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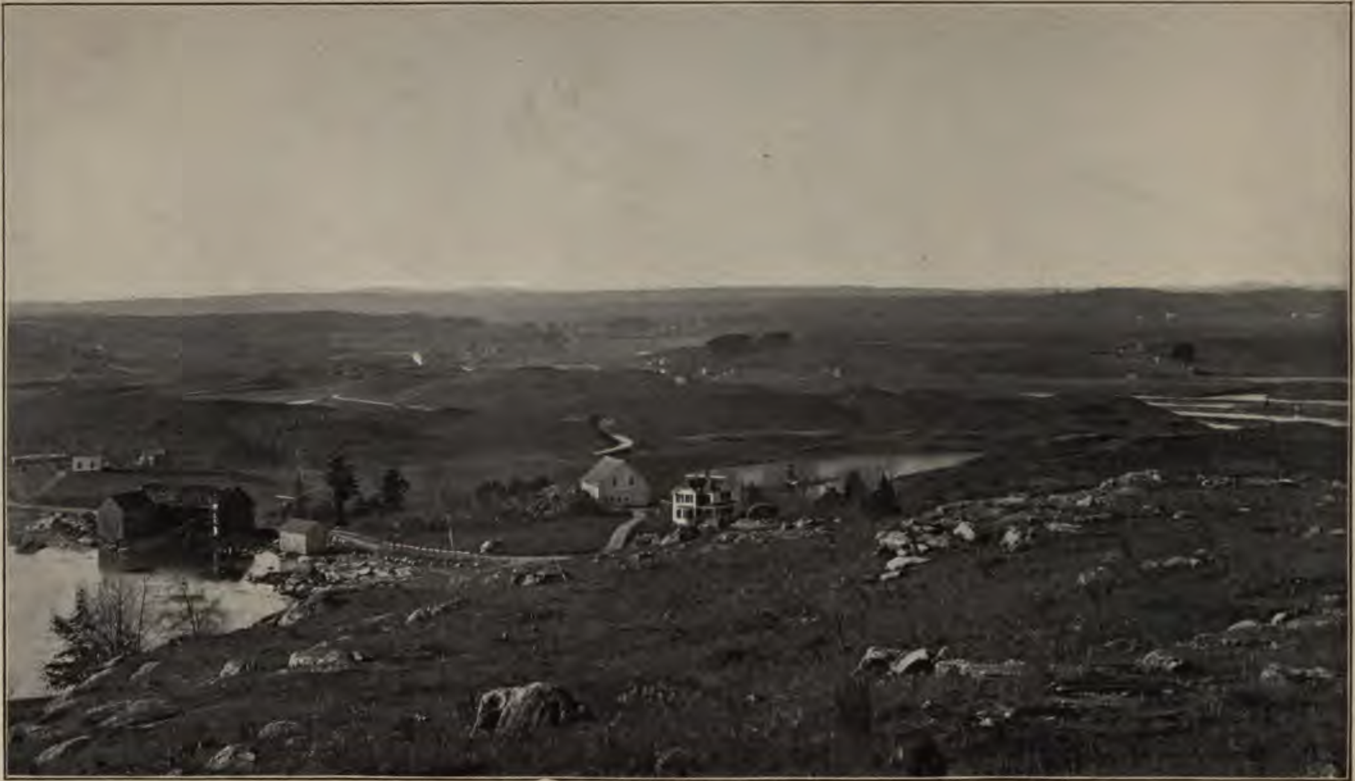
METROPOLITAN WATER BOARD

FOURTH ANNUAL REPORT

JANUARY 1, 1899



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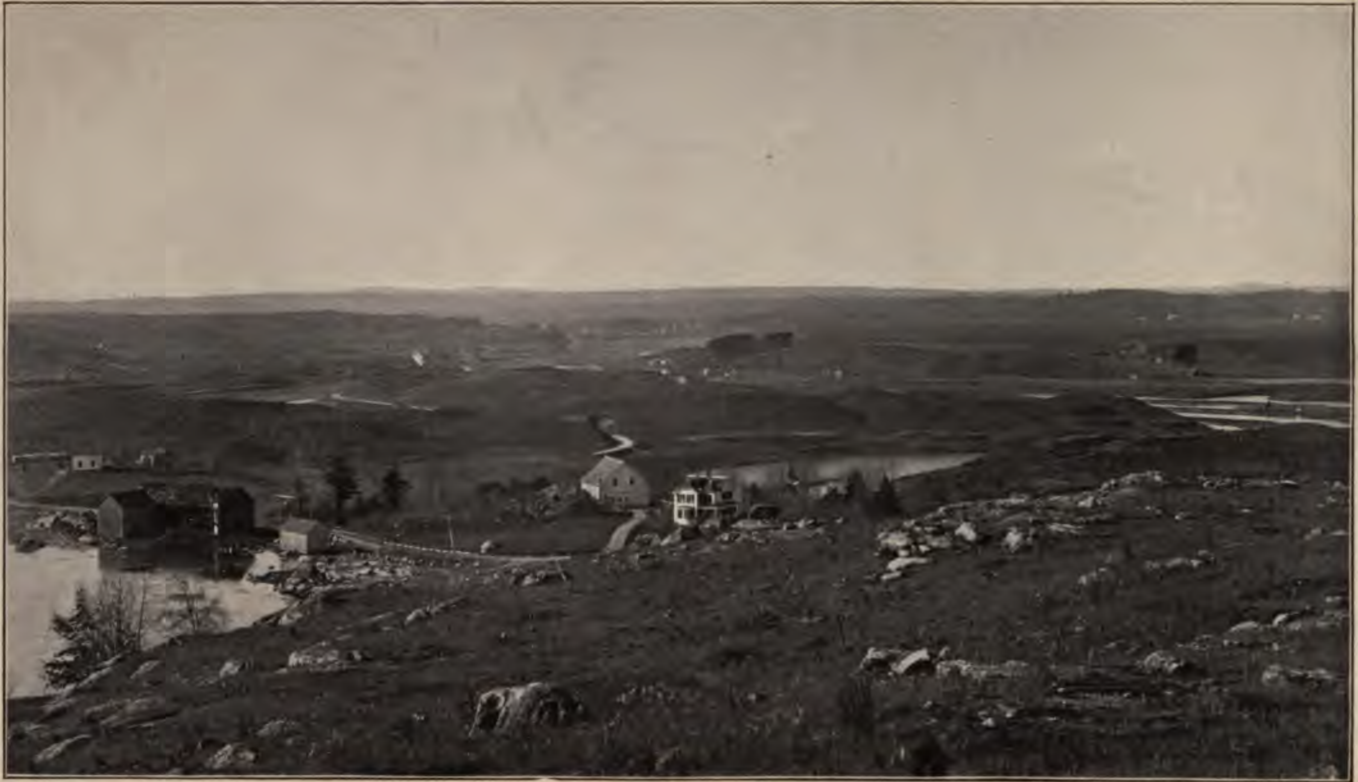

Site of WACHUSETT RESERVOIR—from Hill on estate of Daniel W. Carvill in Clinton.

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OF THE

METROPOLITAN WATER BOARD.

JANUARY 1, 1899.

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METROPOLITAN WATER BOARD.

To the Honorable the Senate and House of Representatives of the Commonwealth of Massachusetts in General Court assembled.

The Metropolitan Water Board, established under the provisions of chapter 488 of the Acts of the year 1895, respectfully submits its

FOURTH ANNUAL REPORT,

being a report of the work and operations of the Board for the year 1898.

I. ORGANIZATION.

(1) *Administration.*

Henry P. Walcott, M.D., whose term of service expired, was reappointed a member of the Board for the term of three years, beginning with the first Monday in May, 1898; and the Board has continued as follows: Henry H. Sprague, chairman, Wilmot R. Evans and Henry P. Walcott, M.D. William N. Davenport has continued as the secretary of the Board, and has acted as its executive officer; and Alfred F. Bridgman has also continued as auditor and accountant.

There has been a slight increase in the number of employés in the administration department, and the office force now comprises a book-keeper, an assistant book-keeper, an assistant in auditing, a paymaster, three stenographers, two messengers and a janitor.

The addition of a stenographer and messenger has not, however, been commensurate with the increase in the amount of work required in the department. The assumption of the operation of the water works acquired from the city of Boston and the beginning of the maintenance of the works constructed by the Board have added largely to the accounts and pay rolls to be kept by the auditor, and have involved many additional details in labor.

The duties of the secretary, as the executive officer of the Board, have likewise much increased. He has been called upon to take part not only in negotiations for the purchase of lands and in the settlement of damages for lands taken by the Board, but also in the investigation of many claims which have been brought for damages to business in West Boylston, Boylston and Sterling, and for loss of wages by employés in West Boylston, whose employment has been taken away by the operations of the Board. The secretary has likewise been called upon to represent the Board in hearings and conferences at the State House, and also before boards and committees in the different towns where the operations of the Board are carried on.

(2) *Engineering Department.*

The engineering department, comprising both the construction of new works and the maintenance of the works of water supply, has been under the direction of Frederic P. Stearns, the chief engineer.

The principal engineers in service have been as follows: —

Chief Engineer, FREDERIC P. STEARNS.
Consulting Engineers, JOSEPH P. DAVIS, ALPHONSE FTELEY.
Engineer of Distribution Department, DEXTER BRACKETT.
Engineer of Sudbury Department, DESMOND FITZGERALD.
Engineer of Dam and Aqueduct Department, THOMAS F. RICHARDSON.
Engineer of Reservoir Department, HIRAM A. MILLER.
Principal Office Assistant, REUBEN SHIRREFFS.

Hiram F. Mills of Lawrence has acted during the year as a consulting engineer in the matter of the construction of the North Dike connected with the Wachusett Reservoir at Clinton.

There have also been employed during the year in the engineering force the following: —

Department engineers,	4
Assistant engineers,	29
Draftsmen,	23
Engineering assistants,	103
Inspectors,	13
Foremen,	1
Clerks,	4
Stenographers,	9
Messengers,	4
A total of	190

The maximum number employed at any one time was 165.

Beside the engineers who have been detailed for purposes of inspection of work, other inspectors, over pipe-making, pipe-laying, machinery, masonry and earthwork, have been employed, to the maximum number of 19.

Laborers have been employed, under the charge of foremen and under the general direction of the engineers, for the construction of a temporary dam and conduit at Clinton, for the clearing of portions of the land comprised within the limits of the Wachusett Reservoir, for the making of borings at the location of the dikes, for the completion of the embankments and the improvement of the lands along the Wachusett Aqueduct, for the digging of drainage ditches in swamps and for work at the pipe yards, in various numbers according to the requirements from time to time, the maximum number at any one time being 291.

Beside those who have been employed in the work of construction, a considerable maintenance force has been employed. The organization at the end of the year included, beside engineers, employés as follows: dam and aqueduct department, 11; Sudbury department, including Sudbury Reservoir, Lake Cochituate and the Sudbury and Cochituate aqueducts, 50; distribution department, including pumping stations, pipe lines and reservoirs, 60; a total maintenance force of 121.

Special engineers, experts, appraisers and others have been employed from time to time in various branches of investigation and service.

There have also been employed by the contractors, in the different works of construction carried on, considerable numbers of men, the largest number at one time being 1,264.

The detailed report of the doings of the engineering department is contained in the report of the chief engineer.

(3) *Conveyancing Department.*

Alfred C. Vinton has continued in the supervision of the conveyancing department, with George D. Bigelow as assistant conveyancer. In the main office there have been regularly employed, in addition, Miss Alline E. Marcy, title examiner, and two stenographers and typewriters. Others have occasionally been employed for special work, as the demand has made necessary.

During the earlier part of the year Charles T. Davis continued as the chief examiner of titles, in charge of the branch office at the Worcester Registry of Deeds. When he entered upon his duties as one of the judges of the new court of registration, the office was placed in charge of Miss Celia M. Tibbetts, who had previously been the chief conveyancing clerk in that office, subject to the more immediate supervision of the assistant conveyancer from the Boston office. Two conveyancing clerks, a stenographer and a messenger have also been employed, under the charge of Miss Tibbetts.

The preliminary work in the Registry of Deeds at Worcester for the examination of the titles of lands in the Wachusett basin was substantially completed early in the year. During the remainder of the year that office has been engaged in the completion of the abstracts of title and in making reports for settlements of titles in the Wachusett basin; and also in examination of titles to additional tracts of land needed for the new sewer line to be completed in Clinton, and for the pumping station and the filtration beds which are to form a part of the Clinton Sewerage System; of the titles for the Crane Swamp improvement, undertaken in order to preserve the purity of the water flowing into the Sudbury Reservoir; and the titles to additional tracts, principally in Lancaster and Clinton, needed for roads, cemetery and other like purposes. This work was greatly facilitated by the efficiency of the chief examiner, Mr. Davis.

Complete titles to the number of 164 have been finished and reported upon during the year, in addition to a large amount of miscellaneous work. Beside performing the work required in the settlement for titles in the Worcester district, the force at that registry is to be continued upon the preparation of such data as is needed for satisfactory information relative to the ownership of estates which may be entitled to damages on account of depreciation in value, but which are not taken for the purposes of the work. There are about three hundred estates outside of the limits of the proposed reservoir embraced in the district from which such claims may be made.

The Boston office, which is required to pass upon the titles, to do the work necessary for the perfection of titles and to prepare the necessary instruments, has acted upon 113 settlements with land owners during the year. These settlements have covered 165 titles, many of which have, however, covered several original titles uniting in a single title at a later date.

During the year the department has drafted, including the takings of January 1, 1898, 18 instruments of takings of lands under the right of eminent domain. These takings embraced parcels in the counties of Worcester, Middlesex, Norfolk and Suffolk, and not only lands taken in fee, but also various other rights and easements in lands, and also the waters of the South Branch of the Nashua River, of Sandy Pond and of a part of Coachlace Pond, with the waters of their various tributaries.

The conveyancing department has, in addition, been called upon to draft various releases of rights and damages and other agreements with parties in relation to real estate, and the necessary instruments for the location of new highways, one to take the place of the River Road in Clinton and Boylston at the south of the new reservoir, and another to extend from Clinton through Sterling to West Boylston upon the north side of the reservoir, and for the discontinuance of portions of the two existing roads.

The department has also been called upon to furnish to the Attorney-General considerable reports for assistance in the suits in court in which petitions for damages have been brought, and also to furnish a good deal of miscellaneous information to the engineers for their guidance in the various parts of their work.

(4) *Police.*

The completion of the Sudbury Reservoir and of the Wachusett Aqueduct has enabled the Board to diminish to a considerable extent the number of officers employed for the police protection of the localities in which the operations of the Board have been carried on. During the early part of the year there was employed a maximum number of 15 officers in Southborough and of 9 in Marlborough, and also 8 officers were employed in Berlin and 7 in Northborough.

The police service in Berlin and Northborough was terminated on March 1, 1898, the force in Southborough was discharged on June 25, 1898, and the police stations maintained in South Berlin and in Fayville were given up. Owing to the work which had to be performed in the northern part of the Sudbury Reservoir for its final completion, the police force in Marlborough was continued until

December 1, 1898. The force in Clinton has been increased from 5 to 6 men, and these officers are under the control of the chief of police of that town.

Frank H. Baldwin, who is also a deputy sheriff for the county of Worcester, has continued to act as the chief officer of the Board in the towns of Boylston, West Boylston and Sterling; and he has, in addition, a general oversight and care of the property of the Board in these towns, as well as in the town of Clinton. He has the assistance of one officer in West Boylston, who has charge of the police station on Clarendon Street, which has been maintained as the general station for the Wachusett Reservoir district.

The expenditures for the police protection which has been afforded to the various portions of the district, in accordance with the requirements of the Metropolitan Water Act, chiefly in the region of the Sudbury Reservoir and the Wachusett Aqueduct, have amounted during the past year to $13,104.91, and to a total since the year 1895 of $73,462.92.

Although so many officers have been supplied, a considerably larger number has been called for by several of the towns in which work has been carried on than the Board felt that it would be justified in furnishing. No serious cases of disturbance have occurred, and it is believed that the various districts in which workmen have been employed have not been greatly disturbed or discommoded by the laborers. The various gangs of workmen have been generally kept in good order and discipline, and the number of arrests, which may be taken as indicative of the amount of disorder, has not exceeded the average in other communities of the State subject to normal conditions.

(5) *Offices and Buildings.*

The interests of the Board have required, in addition to the original quarters at No. 3 Mt. Vernon Street, the adjoining building, No. 2 Mt. Vernon Street; and both these entire buildings are now occupied for the work of the administration, and of the conveyancing and engineering departments. The floor space which is in use comprises an area of 18,200 square feet. These buildings, which belong to the Commonwealth, are devoted to the service of the Board by order of the Governor and Council, and afford accommodations better adapted to its needs than can be secured elsewhere outside of the State House, in which there is no room left for this department of State work. Beside affording so great a space, the buildings are most desirably situated for light and air, being open both in front and rear on quiet streets; and their peculiar situation is such that, though there is lack of their being fireproof, there is little danger of destruction or great injury by fire. It seems almost impossible that quarters of equal capacity and adequate to the requirements of the work could be obtained in such proximity to the State House, and to obtain such quarters outside of the State properties would require the annual expenditure of a large sum of money, and would very considerably increase the current expenses of the Metropolitan Water District, for which the Commonwealth has undertaken to act as trustee.

A small room is still retained in Worcester, near the Registry of Deeds, for the use of the title examiners in Worcester County.

The engineering forces of the dam and aqueduct department and of the reservoir department, which have their headquarters at Clinton, are well accommodated in the spacious and substantially fireproof building which was erected by the Board, and which has admirably served the purposes of its construction.

A branch office of the engineering department engaged in construction of the Wachusett Reservoir has been maintained in West Boylston, and another has been opened near the location of the North Dike in Clinton. The offices formerly maintained at Northborough and at the Sudbury Dam at Southborough for construction work have been continued.

The pipe yards in Brighton and at Forest Hills have continued to be maintained throughout the year; but those at Edgeworth in Malden and on Park Street in Somerville have been given up. To take the place of the pipe yards discontinued, a lot at the corner of Myrtle Street and Amaranth Avenue, in Medford, has been purchased for use as a permanent pipe yard, and as the headquarters of the distribution department for the Northern Metropolitan Water District. The lot purchased embraces an area of 91,276 square feet, and is situated near the Glenwood station of the Boston & Maine Railroad, and a side track is laid from the railroad into the yard. Plans are in process of preparation for the erection of a brick building in the new yard, to be used as an office, shop and stable for the department.

Beside the pumping stations at Chestnut Hill and at Spot Pond, in the service of the maintenance department, and the Mystic pumping station, which is now out of service, a small branch office is maintained at South Framingham; and in connection with the various reservoirs there are dwelling-houses with stables belonging to the Board and occupied by those respectively in charge.

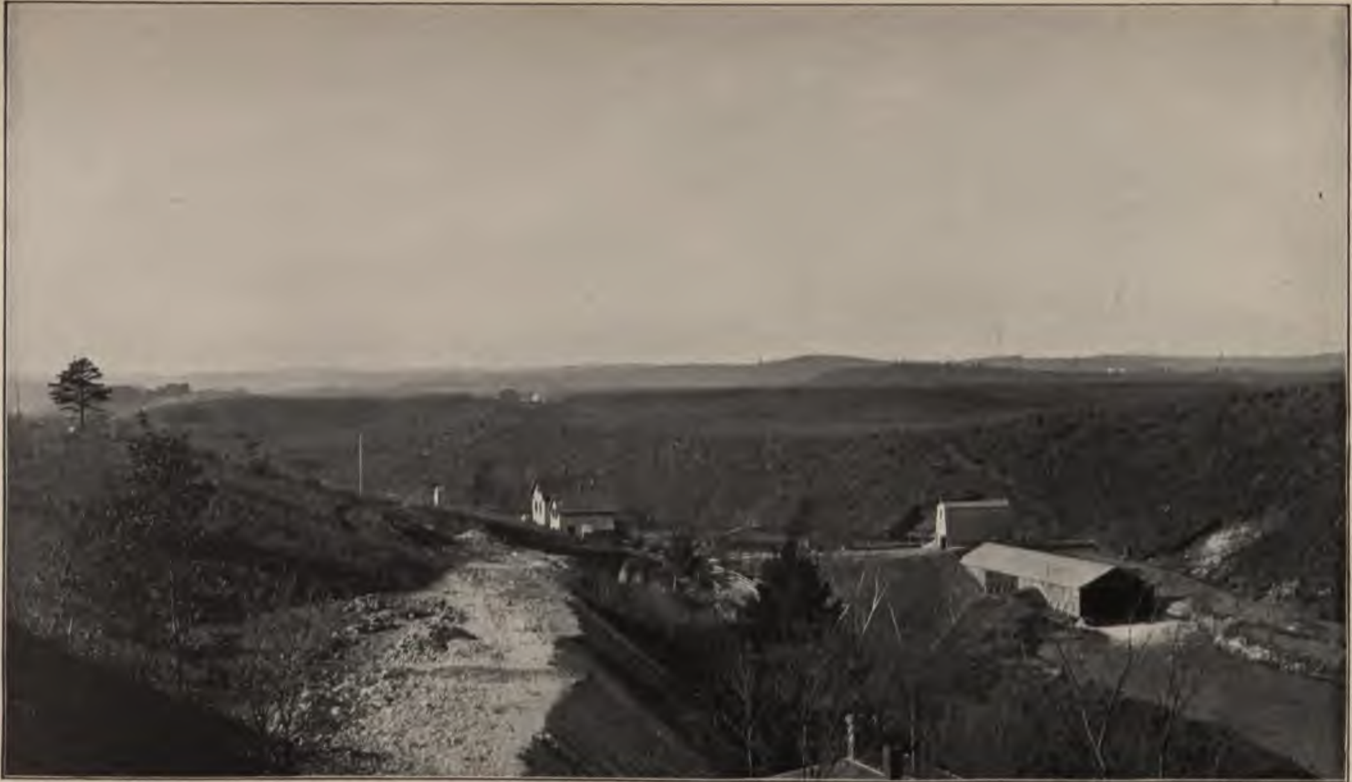
II. WORK OF CONSTRUCTION.

(1) *Wachusett Dam and Reservoir.*

Considerable work has been accomplished toward the construction of the Wachusett Reservoir, although much of this work has still been of a preliminary nature. The field work of the engineering service has been substantially completed, final sectional plans have to a considerable extent been finished, and a beginning has been made in marking by stone bounds the actual margins of the reservoir lands.

The Board has, through the completion of the surveys and plans, been enabled to make takings for the reservoir of about 2,955 acres of land at the Clinton or easterly end, where the actual work of construction is begun. The greater part of the land so taken had already been purchased by the Board, so that but little of it remained in the possession of the former owners. A considerable portion of this, as well as of the remainder of the land which has been purchased, has been cleared by the removal of the wood and timber and the burning of the brush, and many of the buildings have been removed or torn down.

A section of the new road which is to take the place of the River Road between Clinton and Boylston, located in Boylston, had, with the exception of the surfacing, been finished before the beginning of the year; and the remainder of the road, extending easterly to the bridge near the Lancaster Mills in Clinton, has also, with the same exception, been constructed. The latter section was especially difficult and expensive, on account of the desirability of mitigating as much as possible the steepness of the grade at the start of the road in Clinton. The two portions of the road have a total length of about 3 miles, and connect the town of Clinton with Boylston Centre.



Location of Wachusett Dam at Clinton and easterly portion of the site of Wachusett Reservoir.

Plans are making for the extension of this road along the southerly side of the reservoir to West Boylston. In determining the location of the road at the most southwesterly portion of the proposed reservoir, the Board believed that it was expedient that the location should follow substantially the margin of the reservoir, as originally recommended by the State Board of Health. It was, however, unable to agree with the County Commissioners of Worcester County, to whom it was provided, by the Metropolitan Water Act, that the matter should be referred, the commissioners being of the opinion that the road should be extended through the reservoir substantially along the line of the present Dover Road, so-called, leading from Boylston Centre to West Boylston. Inasmuch as the Board deemed that the building of a deep embankment across the reservoir, with the culvert required, would not only involve a serious annual burden to the town of Boylston for maintenance, but would also entail for construction an unreasonable expenditure on the part of the Commonwealth, nearly equal in amount to one-half of the valuation of the town of Boylston, and, moreover, that the route favored by the commissioners would better accommodate even a less number of people than the proposed marginal road, it has applied, under the terms of the Act, to the Highway Commission of the Commonwealth, to adjudicate finally upon the matter.

Work has also been begun in the construction of the road which is to extend along or near the North Dike, upon the northerly side of the reservoir, from Clinton to West Boylston and Sterling, and is to take the place of other roads which will be submerged.

A considerable beginning has been made in the construction of the North Dike, which is to be built northwestward of the main dam. A dike has been built through Coachlace Pond, and Sandy Pond has been drawn down; a part of the trench, which is to be cut along the line of the North Dike and filled with impervious material, has been dug; and a considerable portion of the bed of the railway, which will have to be constructed in order to transfer the large portion of the surface soil to the North Dike, has been completed; so that it is felt that a substantial and successful beginning has been made in the construction of the great reservoir.

Owing to the necessity which had arisen for taking the whole of the St. John's Catholic Cemetery in Clinton, and the consequent occasion which arises for the removal of all the bodies which are there deposited, the Board entered into an agreement with the Right Reverend Thomas D. Beaven, the Roman Catholic Bishop of Springfield, who is the owner in fee of the cemetery, and the St. John's Catholic Cemetery Association, by which it was provided that a tract of land should be acquired in the southerly part of Lancaster, in which the bodies shall be deposited, and that the work of removal shall be carried on by the Cemetery Association. It is provided by the agreement that instalments shall be paid as the work proceeds; and that, upon the removal therefrom of all the bodies and structures now contained in the present cemetery, and the conveyance of the land to the Commonwealth, free from all claims arising against the Board or the Commonwealth, the Board will pay to the Bishop and the Association the balance of the amount of $92,500 not previously advanced. Satisfactory preparations have been made at the new ground for the receiving of the bodies, and it is expected that the proper arrangements will be made so that the actual work of removal can begin as early as the season will allow. The Board entered into this arrangement with the desire and belief that by means of it the people of Clinton will obtain the most satisfactory place of burial for the remains of their dead, and that the delicate and responsible work of removal will be effected in a proper and satisfactory manner by those most interested in the result.

The work of making investigations and studies for the construction of the Wachusett Dam has been continued throughout the year, and it was hoped that the active construction could be begun with the beginning of the present season. It has, however, been found impossible to complete plans and specifications and to begin actual work in the earlier part of the year.

The temporary dam, built for the purpose of diverting the waters of the river into the Wachusett Aqueduct, and which will also serve as a temporary dam to aid in the prosecution of the work of constructing the main dam, was finished in February; and on March 7 the gates were opened, and the waters of the Nashua River were actually diverted into the Wachusett Aqueduct, and have been flowing through the aqueduct since that date.

The following is a summary showing the purposes of expenditures on account of the Wachusett Dam, Reservoir and Watershed: —

	For the Year ending Dec. 31, 1898.	From Beginning of Work, and ending Dec. 31, 1898.
Contracts for construction, ...	$79,795 96	$105,689 15
Real estate: —		
Mill property and water rights, . . .	100,000 00	1,111,000 00
Other property, for reservoir and margins, . .	327,545 47	780,987 22
Outlying property, ...	7,738 00	13,747 00
Engineering, ...	60,143 79	164,888 51
Preliminary and additional work, taxes and other expenses, ...	127,360 46	292,328 76
Totals, ...	$702,583 68	$2,468,640 64

(2) *Wachusett Aqueduct.*

The last 3 miles of open channel of the Wachusett Aqueduct were finally completed, so that the water could be admitted through the aqueduct, on March 7, 1898.

The final settlement with the contractors for the building of the open channel has not been effected, but the entire cost of the aqueduct will vary but little from $1,750,000.

Work has been continued during the year in clearing up and grading the grounds along the aqueduct and removing the débris left after the construction of the work, in the erection of stone bounds to mark the centre line of the aqueduct and the boundary lines of the lands taken, and in the building of fences along the aqueduct where the lands are used for pasturage.

Considerable work has also been done toward providing satisfactory supplies of water to people whose wells or springs were injured by the construction of the aqueduct.

Further settlements have been made with the owners of the land which was taken, so that now, of the total of 44 claims for land damages on account of the 9 miles of tunnel and covered aqueduct, settlements have been accomplished in 41 cases; and of the 22 claims for damages for land taken for the last 3 miles of open channel, settlements have been made in 5 cases.

The following table shows the purposes of the expenditures on account of the Wachusett Aqueduct: —

	For the Year ending Dec. 31, 1898.	From Beginning of Work, and ending Dec. 31, 1898.
Contracts for construction,	$121,617 18	$1,415,495 84
Real estate settlements,	16,388 90	48,311 40
Engineering,	18,538 29	158,441 17
Preliminary and additional work and other expenses,	33,704 22	91,156 29
Totals,	$190,248 59	$1,713,404 70

(3) Clinton Sewerage.

The Metropolitan Water Act provided that the Board should compensate the town of Clinton for the damages which should be sustained by the town by any interference with its sewerage system or with its drainage rights or privileges. The sewage of the town is disposed of by conveying it into the Nashua River; and, although the time would come when such disposal would, in the natural course of events, so affect the water of the river as to be a serious injury to the inhabitants below upon the stream, the summary diversion of so large a portion of the water by the operations of the Board will undoubtedly make objectionable the further deposit of the sewage in the river. After conference with the officials of the town it was arranged that authority should be sought from the Legislature, so that the Board itself should construct, and for a period maintain and operate, works for intercepting the sewage of the town at its two principal outlets into the Nashua River, and for conveying the sewage and properly disposing of it within certain defined limits of the towns of Clinton and Lancaster.

An act was accordingly passed, and approved on June 22; and in pursuance thereof it was determined, after careful investigations, that intercepting sewers should be built from the outlets to a point in the northerly part of Clinton adjoining High Street and the river, where a receiving basin should be built and a pumping station erected, so as to pump and convey the sewage into filter-beds to be built on a sandy plain easterly of High Street in the southerly part of Lancaster.

The necessary land for the various works was taken, and contracts have been made for the construction of nearly all the work except for the building of the pumping station. The filter-beds have been nearly completed, and considerable progress has been made under the remainder of the contracts, and the whole work will be completed during the coming season.

It is provided by the Act of 1898 that the Board shall maintain and operate the works, unless otherwise agreed by the Board and the town, until the sewage of the town shall have outgrown the normal capacity of the river properly to dispose thereof; at which time the Board shall transfer all the works to the town, on terms to be agreed upon as just and proper, or, in case of failure so to agree, upon terms which shall be determined to be just and proper by the Supreme Judicial Court.

(4) *Sudbury Reservoir.*

The only portions of the Sudbury Reservoir which were uncompleted at the beginning of the year were the section near the Sawins Dam and the northerly sections in the city of Marlborough. Work upon the former section had been delayed by reason of an injunction obtained by the trustees of the estate of Joseph Burnett. This injunction was dissolved by order of the Supreme Court of the Commonwealth in November, 1897, subsequent to a decision which upheld the constitutionality of the Metropolitan Water Act. An appeal from this decision has been taken, however, by the trustees, to the United States Supreme Court, upon the question of the constitutionality of the Act. The work upon this section was renewed immediately upon the dissolution of the injunction, and was completed early in the spring. The work upon the Marlborough sections had, in March, been carried so far that water could then be introduced from the Nashua River; and the reservoir was filled early in April by the additional supply.

The reservoir was kept full until August, when the water was lowered sufficiently for the completion of the work in the Marlborough sections, in which a large amount of mud at the bottom remained to be removed. This work was entirely completed on

December 9, and the Nashua water has again been introduced into the reservoir.

This reservoir will henceforth afford a storage capacity of about 7,250,000,000 gallons, — a storage which will enable the district to receive and enjoy to a large extent the better water which comes from the Nashua River.

The roads in Southborough and Marlborough, which were built to take the place of the various roads in those towns that were submerged by the building of the reservoir, have been put into satisfactory condition, and those in Southborough have been accepted by the County Commissioners. In Southborough, 7,000 feet in length of new roads were built, 25,760 feet of roads rebuilt, and 44,450 feet of roads discontinued; 1,895 feet of roads were rebuilt in Marlborough.

Nearly all of the claims for the takings of lands and the doing of other injuries in the construction of the Sudbury Reservoir have been settled, there remaining only 6 claims for which suits are now pending.

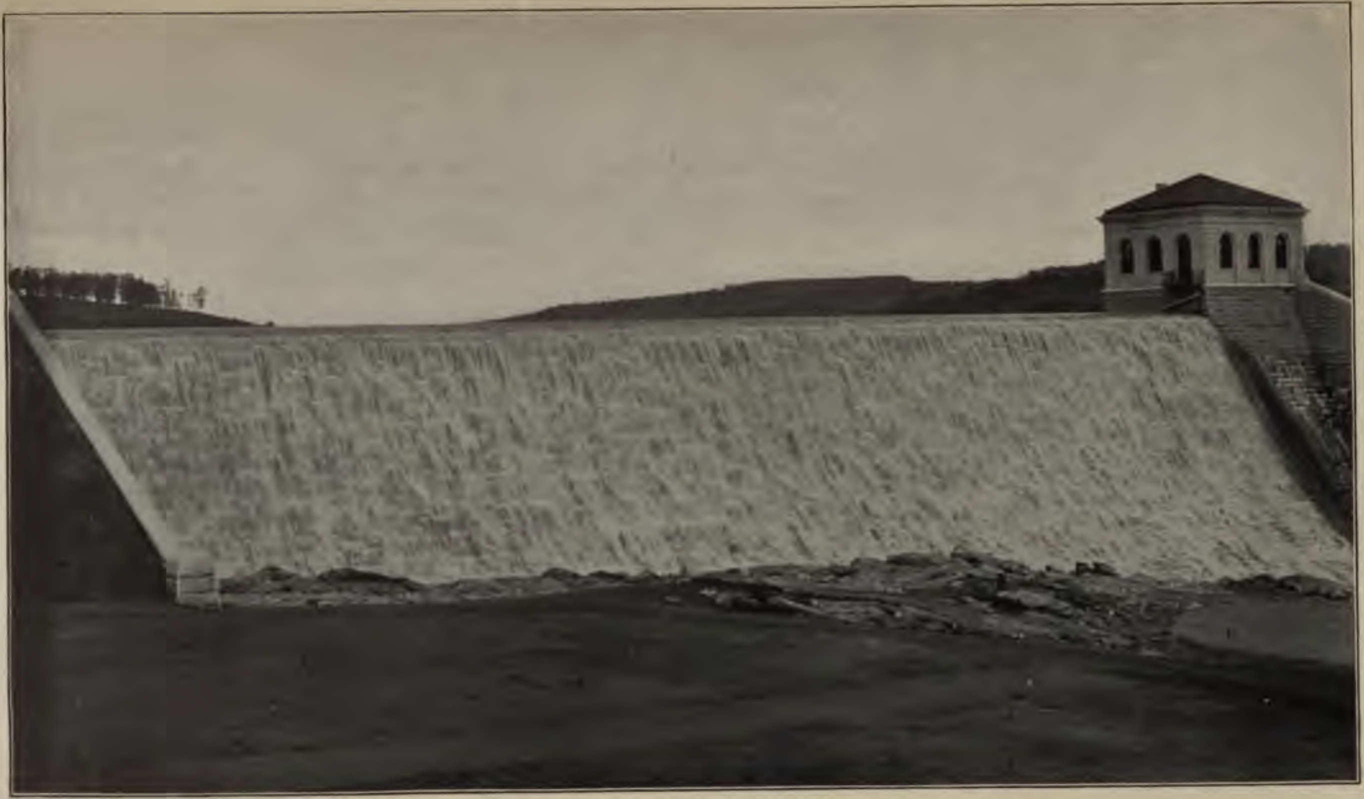
The following is a summary of the purposes of the expenditures made on account of the Sudbury Dam and Reservoir: —

	For the Year ending Dec. 31, 1898.	From Beginning of Work, and ending Dec. 31, 1898.
Contracts for construction, ...	$119,373 82	$1,908,457 08
Land settlements, ...	57,473 60	591,848 28
Engineering, ...	16,320 39	169,328 99
Preliminary and additional work and other expenses, ...	20,808 38	168,477 43
Totals, ...	$213,976 19	$2,838,111 78

(5) *Improvement of the Sudbury Watershed.*

Considerable work has been done during the past year for the improvement of the water in the Sudbury watershed.

One of the principal brooks which enters the Sudbury Reservoir passes through thickly settled portions of the city of Marlborough. Land was bought and a beginning had been made by the



SPILLWAY OF SUDBURY DAM AT SOUTHBOROUGH—OUTLET OF SUDBURY RESERVOIR.

city of Boston in the building of filter-beds for filtering the water before it was allowed to flow into the reservoir. This work has been resumed, and the construction of a settling reservoir has been completed, from which water will flow into filtration beds and thence into the reservoir. By these means a large source of pollution of the waters of the reservoir will be avoided.

A beginning has also been made in the draining of swamps which are tributary to the open channel of the Wachusett Aqueduct, and which are within the Sudbury watershed. The water in collecting and flowing through the swamps acquires a deep brown color, and also takes up much organic matter. Under the operations which have been entered upon, ditches of sufficient size to convey all the water flowing into the swamp are dug, and the water is diverted into the open channel or other main stream comparatively unaffected by the organic matter of the swamps. The water is still further improved by providing for settling basins where the ditches enter the open channel. The swamps themselves, being thus isolated, become moderately dry and consequently much less injurious.

Operations similar to those which have been begun in two or three of the smaller swamps will be carried on in the large swamp situated in the towns of Westborough and Northborough, known as Crane Swamp, a considerable portion of which has already been acquired by the Board for the purposes necessary for carrying out the improvement.

(6) *Taking of the Water Works of the City of Boston.*

At 12 o'clock on the first day of January, 1898, the Board, in accordance with the provisions of the Metropolitan Water Act, took possession of Chestnut Hill Reservoir and pumping station, and all the lands, reservoirs, dams, aqueducts, pumps and other property, held by the city of Boston westward of Chestnut Hill Reservoir for the purposes of storing and supplying water and protecting its purity, including Lake Cochituate and the Cochituate Aqueduct, the Sudbury basins and Sudbury Aqueduct, and the Mystic Lake, aqueduct, pumping station and reservoir. The lands taken were situated in the counties of Suffolk, Norfolk, Middlesex and Worcester. All these works were added to those which had been previously acquired and constructed by the Board, and the whole constitute the Metropolitan Water Works.

For the works taken the city of Boston is to be compensated by the Board, and a sum of $5,000,000 has already been paid to the city on account, in addition to $1,154,766.84 paid to the city in reimbursement for its expenditures in the partial construction of the Sudbury Dam and Reservoir, which had previously been taken by the Board.

For the purpose of making more effective the Sudbury Aqueduct, it was found necessary to proceed at once to the building of an additional siphon pipe across the valley of Rosemary Brook in the town of Wellesley. The capacity of the Sudbury Aqueduct was limited by the capacity of the two 48-inch siphon pipes laid across this valley and connecting the two portions of the aqueduct, to about 80,000,000 gallons per day, the remainder of the aqueduct being capable of carrying upwards of 100,000,000 gallons; consequently, a pipe 61 inches in diameter has been laid, at a total cost of $23,034.05, which, with the other two pipes, will permit the flow of all the water which the aqueduct is capable of carrying.

By arrangements made with the city of Boston, an enlargement of the Chestnut Hill high-service pumping station had been begun, under plans furnished by Wheelwright & Haven, by the Board before the beginning of the year. The addition has been satisfactorily completed, and rather adds to than impairs the architectural effect of the pumping station.

The 30,000,000 gallon pumping engine, for which a contract had been made with the E. P. Allis Company, has been received and set up in the addition to the building, and has, with the new 90-inch Belpaire boiler also provided, been put into successful operation, although the covering, electric light wiring and other details have not been finished. The substantial completion and operation of this engine, as well as the laying of the additional Rosemary Brook siphon pipe, have done much toward utilizing the additional supply of water which has been acquired.

On August 26 the contract was made for the erection at Chestnut Hill of a new low-service pumping station, in accordance with plans prepared by Shepley, Rutan & Coolidge. This pumping station is to be built a short distance to the eastward of the present high-service pumping station. The building of suitable foundations for the structure has been a matter of much difficulty, owing to the fact that the land had formerly been filled with boulders, rock and earth taken from the site of the reservoir.

Head of SUDBURY RESERVOIR adjacent to the estate of the late Joseph Burnett.

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ASTOR, LENOX AND
TILDEN FOUNDATIONS.

A contract has been made with the Holly Manufacturing Company for furnishing three pumping engines, each with a capacity of 35,000,000 gallons per day, which are to be placed in the pumping station when completed. By the operation of these engines an additional pressure of from 20 to 30 feet will be insured for the larger part of the city of Boston.

(7) *Spot Pond.*

At the same time that the works of water supply of the city of Boston were taken, a taking was also made of Spot Pond and the adjoining lands, together with the Melrose pumping station and one of the Medford and one of the Malden pumping stations. These lands were taken from the cities of Malden and Medford and the town of Melrose, which had exercised a joint ownership over the larger part of them.

Spot Pond was acquired as a distributing reservoir for the northern low-service district. It has already been connected by one 48-inch pipe leading from the Chestnut Hill Reservoir, and subsequent connection will be made by another like pipe main which has been nearly completed; and the water entering at the Chestnut Hill station is pumped from that station into Spot Pond, which has an elevation of 20 feet above Chestnut Hill Reservoir.

Owing to the fact that no operations were ever undertaken for the removal of the organic matter from the bottom of the pond or from the shores after the raising of the water, and the further fact that large portions of the pond are so shallow that the flats are exposed whenever the water is drawn down to any considerable extent, the water of the pond is of an inferior quality, and contains disagreeable, though not unwholesome, matter.

It was within the original intention of the Metropolitan Water Act that the mud and other objectionable features of this pond should, as soon as reasonably possible, be removed, and that the pond should be put into the most effective condition as a storage and distributing reservoir for the northern service. Extensive investigations have been made in regard to the proper treatment of the pond for the purpose to which it is to be devoted, and as to the necessity for providing by a raising of the surface of the pond, or otherwise, an additional storage capacity and an increased water pressure.

It is the purpose of the Board to interfere with the natural beauty of the pond, as well as with the general attraction of the Fells, to the least possible extent required for the insuring of a constant and sure supply of pure water. It is probable that the work of improving the pond will be undertaken, and, if possible, finished, during the coming season.

(8) *Spot Pond Pumping Stations.*

The old Medford pumping station upon the south shore of Spot Pond and the Malden station on the east shore, which were acquired by the taking of January 1, 1898, are considered useless for the operations of the Board; but the Melrose pumping station upon the easterly side of the pond is continued in operation for the supply, not only of Melrose, but of other portions of the district.

The Board has acquired a tract of land on the shore of the pond somewhat northerly of the Melrose station, not far from the Langwood Hotel, for the erection of a northern high-service pumping station. The plans for the building of the station have been prepared by the engineers and by Shepley, Rutan & Coolidge, and the contract for its erection has been executed.

A contract has likewise been made with the Holly Manufacturing Company for furnishing and erecting at this station a pumping engine with a capacity of 20,000,000 gallons per day; and it is proposed also to remove to this station one of the pumping engines now at the Mystic pumping station. The water will be pumped at this station from Spot Pond to the high-service reservoir in the Middlesex Fells.

(9) *Northern High-Service Reservoir in Middlesex Fells.*

The plans for the construction of a northern high-service reservoir in the Middlesex Fells, about 2,500 feet southeasterly from Spot Pond, were completed early in the year. The reservoir is located in a natural basin, at so high a point in the Fells that the surface of the water in the reservoir will be 137 feet above Chestnut Hill Reservoir, and 117 feet above Spot Pond. The larger part of this natural basin is so surrounded by rocks that the work of construction consists largely in the removing of the soil and mud to the surface of the rocks. Five short dams, having an aggregate length of less than 1,000 feet, are required to complete the reservoir, which will have an area of more than 8 acres and a capacity exceeding 38,000,000 gallons.

The soil is removed and deposited in such a manner as to interfere as little as possible with the surrounding contour of the territory, and it is hoped that when completed the reservoir will be an added attraction, rather than an injury, to the park.

(10) The Main Distributing Pipe Lines.

The laying of main lines of water pipes to connect the various parts of the district with the distributing reservoirs at Chestnut Hill and Spot Pond has been continued. During the year 14.43 miles of pipe have been laid, making a total of 57.18 miles laid since the Board began operations. The Board has added by its takings 6.64 miles of pipes, so that it now owns and operates 63.82 miles of main pipes. The pipes which have now been laid are sufficient to afford a full supply of water to the cities and towns in the Metropolitan Water District, except Nahant, which has recently been admitted into the district, and Newton and Hyde Park, which have as yet made no request for water.

Of all the pipes laid, 22.88 miles have been 48 inches in diameter, and the remainder have varied from 42 inches to 6 inches in diameter.

The principal pipe mains laid during the past year have been the lines to Quincy and to the high-service districts of West Roxbury and Dorchester, through North Harvard Street in Brighton, and in Revere, Saugus and Lynn for the supply of Nahant and Swampscott.

The total number of tons of pipes laid up to this time, including a comparatively small amount taken by other departments, is 69,227, of which about 12,501 tons were laid in the year 1898. This amount does not include the many valves of various sizes, and other castings for gates and chambers, which have been required, nor does it include 6,470 tons which have been purchased but not yet laid.

The work of laying the pipes has in general been satisfactorily performed by the various contractors, and in most cases as little annoyance as reasonably possible has been occasioned to the abutters along the different lines. Considerable disturbance and trouble were inevitable; but, with very few exceptions, the people concerned have borne with patience and without complaint the necessary inconvenience.

In a few cases the contractors have not pursued their work as speedily as was possible, and in some cases the streets through which the pipes have been laid have not been satisfactorily restored to a proper condition, and the Board has been compelled to interfere. In other cases it has not been possible to restore at once the various streets to the condition in which they were; but work is required to be done after a considerable period has elapsed, and an opportunity has been given for the settling of the ground, which no amount of care or labor could prevent.

The following is a summary of the purposes of the expenditures for pipe lines and connections in the distribution system: —

	For the Year ending Dec. 31, 1898.	From Beginning of Work, and ending Dec. 31, 1898.
Contracts for pipes, valves, pipe-laying, etc.,	$376,012 19	$1,888,314 85
Less value of pipes, valves, etc., purchased and sent to store yards in previous years, but transferred to works and included in cost of same for the current year,	129,578 36	
	$246,433 83	
Land settlements,	2,925 00	6,511 50
Engineering,	38,037 29	152,040 17
Preliminary and additional work and other expenses,	46,406 66	123,994 59
Totals,	$333,802 78	$2,170,861 11

(11) *Takings and Purchases of Land.*

It has been the policy of the Board, from the outset, to acquire, so far as possible, the various lands and estates required for its operations, by deed, through voluntary settlements with the various owners. In this way more than five-sixths of the land in Clinton, Boylston, West Boylston and Sterling, required for the Wachusett Reservoir, has been conveyed to the Commonwealth after voluntary settlements of value with the owners. After purchase, the formal taking of all rights in the land is made under the authority of the Act. In cases where settlements have not been reached, takings have necessarily preceded a purchase or release, when the time has come to enter upon the lands for beginning operations. In all such cases releases have been obtained from the owners on payment of damages for the takings.

The number of acres of land, with the buildings thereon, which have thus been either conveyed or released to the Commonwealth during the past year has been 1,561.44, for which the owners have been paid the sum of $524,504.79 ; and the total number of acres so conveyed or released since the beginning of operations has been 7,788.76, involving the payment of $2,619,465.54. Settlements were thus made with 112 different parties during the year, and with 407 parties since the beginning. The sums paid have included the compensation for the water privileges, mills and machinery connected with the lands acquired.

The following table shows the number of settlements made, the number of acres settled for, and the amounts paid in the various localities, both for the year 1898 and since the beginning of the work: —

Summary of Land Settlements to December 31, 1898.

LOCATION.	FOR THE YEAR 1898.			FROM BEGINNING OF WORK.		
	Area in Acres.	No. of Settlements.	Payments.	Area in Acres.	No. of Settlements.	Payments.
Wachusett Reservoir.						
Clinton, . . .	216.70	75	$435,283 47	889.52	213	$1,905,734 22
Boylston, . . .	539.14			2,290.53		
West Boylston, . .	371.91			1,099.69		
Sterling, . . .	44.98			485.69		
Lancaster, . . .	14.47			14.47		
Total, . . .	1,187.20	75	$435,283 47	4,779.90	213	$1,905,734 22
Wachusett Aqueduct.						
Berlin, ...	12.11	17	$16,388 90	42.44	43	$48,311 40
Northborough, . .	46.71			71.15		
Southborough, . .	3.15			9.23		
Marlborough, . .	7.88			34.66		
Clinton, . . .	-			11.87		
Total, . . .	69.85	17	$16,388 90	169.35	43	$48,311 40
*Sudbury Reservoir.**						
Southborough, . .	99.84	7	$57,473 60	1,966.21	142	$629,474 60
Marlborough, . .	86.82			746.06		
Total, . . .	186.66	7	$57,473 60	2,712.27	142	$629,474 60
Improvement Sudbury Watershed.						
Northborough, . .	37.43	8	$1,864 50	37.43	8	$1,864 50
Westborough, . .	34.71			34.71		
Total, . . .	72.14	8	$1,864 50	72.14	8	$1,864 50

* Including settlements made by city of Boston.

Summary of Land Settlements to December 31, 1898 — Concluded.

LOCATION.	For the Year 1898.			From Beginning of Work.		
	Area in Acres.	No. of Settlements.	Payments.	Area in Acres.	No. of Settlements.	Payments.
Clinton Sewerage System.						
Lancaster, . . .	43.21	4	$4,180 00	43.21	4	$4,180 00
Total, . . .	43.21	4	$4,180 00	43.21	4	$4,180 00
Distribution System.						
Boston, ...	.24	3	$9,314 32	.35	9	$29,900 82
Brookline, . . .	.05			.05		
Medford, . . .	2.09			2.27		
Quincy, . . .	-			5.23		
Stoneham, . . .	-			3.99		
Total, . . .	2.38	3	$9,314 32	11.89	9	$29,900 82
Aggregates, . .	1,561.44	114	$524,504 79	7,788.76	419	$2,619,465 54

The total number of takings of lands and easements since the beginning of the work has been 38, of which 18 have been made during the past year. The takings in fee made the past year are computed to embrace 6,850.40 acres, and all the takings in fee to embrace 9,858.67 acres. These include the takings made on January 1, 1898, of the water works of the city of Boston, embracing the Sudbury, Cochituate and Mystic works, and also the takings of Spot Pond and the lands immediately surrounding the pond, from the cities of Medford and Malden and the town of Melrose. Other takings are of lands for the roads to be constructed on the north and south sides of the Wachusett Reservoir; lands included in the easterly portion of the Wachusett Reservoir in Clinton, Boylston and Sterling, where the work of construction has been begun; lands for the Wachusett Aqueduct, and for the standpipe and reservoir in Quincy; and smaller parcels for various purposes in different parts of the Metropolitan District. Considerable parcels were also taken in Lancaster under the special Act of 1898 for the construction of the Clinton sewerage works. The takings for easements only include rights to lay and maintain pipe lines in Berlin, at Orient Heights in Boston, in Newton, and in and near Reservoir Lane in Brighton and Brookline. Of the entire number of acres taken in fee, exclusive of the lands taken from the cities of Boston, Malden and Medford and the town of Melrose, 2,076.28

acres had either been conveyed to the Commonwealth prior to the takings or have since been released; so that at the present date there are only 704.88 acres of land taken by the Board for the Metropolitan Water Works, exclusive of the lands so mentioned, which have not been released by the owners and which are consequently not settled for. No lands or easements in lands have yet been taken in West Boylston, as the active operations of the Board in the construction of the Wachusett Reservoir have thus far been confined to Clinton, Boylston and Sterling.

The following is a complete list of takings since the beginning of the work: —

No.	LOCATION AND DESCRIPTION.	Former Owners.	Recorded.	Purpose of Taking.
1	Southborough (also water rights of Sawin, and right to fill Kidder, Deerfoot Farm Co. and Burnett lands). Area, estimated at 1,859.46 acres in fee.	City of Boston.	1896. Jan. 4.	Sudbury Reservoir.
2	Marlborough. Area, 654.33 acres in fee.	City of Boston.	Jan. 4.	Sudbury Reservoir.
3	Clinton and Berlin (from land of D. W. Carvill to land of Alfred C. Derby). Area, 26.62 acres in fee; easements in 0.30 acre (estimated).	Daniel W. Carvill *et al.*	April 13.	Wachusett Aqueduct.
4	Clinton (Boylston Street and Wilson Street to land of D. W. Carvill, near Clam Shell Pond). Area, 1.73 acres in fee; easements in 0.24 acre (estimated).	Henry A. Eckstein *et al.*	May 9.	Wachusett Aqueduct.
5	Berlin and Northborough (from land of Lizzie J. Spofford to boundary line between Northborough and Marlborough). Area, 104.71 acres in fee; easements in 3.69 acres (estimated).	Alfred C. Derby *et al.*	May 27.	Wachusett Aqueduct.
6	Marlborough (from boundary line between Northborough and Marlborough to land of Thomas Connors). Area, 3.85 acres in fee; easements in 0.08 acre (estimated).	New York, New Haven & Hartford Railroad, Chloe Ann Ballou, Lois E. Brigham.	June 8.	Wachusett Aqueduct.
7	Marlborough (from boundary line between Northborough and Marlborough to boundary line between Marlborough and Southborough). Area, 32.39 acres in fee.	Lois E. Brigham *et al.*	Sept. 28.	Wachusett Aqueduct.
8	Northborough and Southborough (from boundary line between Marlborough and Northborough to land of Lettie A. Knight). Area, 105.88 acres in fee; easements in 0.60 acre (estimated).	Lois E. Brigham *et al.*	Sept. 28.	Wachusett Aqueduct.
9	Boston (Commonwealth Avenue to Charles River). Area, 0.11 acre in fee; easements in 0.69 acre.	Ebenezer Francis Estate, Boston & Albany Railroad, Eben D. Jordan Estate.	1897. May 14.	Pipe line.

No.	LOCATION AND DESCRIPTION.	Former Owners.	Recorded.	Purpose of Taking.
10	Southborough (south of road from Marlborough to Westborough). Area, 9.29 acres in fee.	David O'Connell.	1897. June 1.	Wachusett Aqueduct.
11	Quincy (land and roadway on Forbes' Hill). Area, 5.22 acres in fee; easements in 1.78 acres (estimated).	City of Quincy.	June 23.	Stand-pipe.
12	Malden (proposed extension of Jackson Street). Area, easements in 0.35 acre (estimated).	M. Cashman *et al.*, Henry Carmichael, Evelina H. Dowling.	June 28.	Pipe line.
13	Southborough (Burnett property). Area, easements in 7.31 acres.	Josephine Kidder and Burnett Estate.	July 6.	Sudbury Reservoir.
14	Boylston (in the northerly part, on road from Clinton to Boylston). Area, 142.46 acres in fee.	Geo. R. Hastings *et al.*	July 26.	Highway, Wachusett Reservoir.
15	Berlin (near South Berlin Station of the N. Y., N. H. & H. Railroad). Area, 0.06 acre in fee.	Nathan and Elizabeth S. Severance.	July 26.	Highway, Wachusett Aqueduct.
16	Allston (near Boston & Albany Railroad Station). Area, easements in 0.03 acre.	Boston & Albany Railroad.	Sept. 4.	Pipe line.
17	Clinton (along River Road). Area, 61.47 acres in fee; easements in 0.49 acre (estimated).	M. A. S. Forbes, Kiessling and Cunningham.	Oct. 1.	Wachusett Reservoir.
18	Chelsea (Murray Street, Summit Avenue and Powder Horn Hill). Area, easements in 1.13 acres.	City of Chelsea *et al.*	Oct. 25.	Pipe line.
19	Brighton (North Harvard Street and Charles River). Area, 0.24 acre in fee.	Harvard College.	Oct. 26.	Pipe line.
20	Marlborough (Broad Meadow, near Farm Street). Area, 0.45 acre in fee.	Charles J. Taft.	Oct. 30.	Sudbury Reservoir.
21	Boston (Chestnut Hill Reservoir, Cochituate and Sudbury aqueducts and pipe lines). Area, 160.34 acres in fee; easements in 0.29 acre (estimated).	City of Boston.	1898. Jan. 1.	- -
22	Marlborough, Hopkinton, Ashland, Framingham, Wayland, Sherborn, Natick, Newton, Woburn, Winchester, Arlington, Medford and Somerville. Area, estimated at 2,879 acres.	City of Boston.	Jan. 1.	- -
23	Wellesley and Needham (parts of Sudbury and Cochituate aqueducts). Area, 170.81 acres in fee.	City of Boston.	Jan. 1.	- -
24	Westborough and Southborough. Area, 563.08 acres in fee (estimated).	City of Boston.	Jan. 1.	- -
25	Stoneham and Medford (Spot Pond). Area, 220.62 acres in fee.	Malden, Medford and Melrose.	Jan. 1.	- -
26	Berlin (in the westerly part). Area, 0.18 acre in fee; easements in 1.92 acres.	Eliza Barnes, Jonas H. Carter *et al.*	Feb. 7.	Water supply pipe at West Berlin.
27	Waters of South Branch of the Nashua River, and Sandy Pond at Clinton.	- -	Feb. 23.	- -
28	Clinton (on South Meadow Road and Boston & Maine Railroad), Sandy Pond and Coachlace Pond. Area, 180.91 acres in fee.	Heirs of Owen Kerley *et al.*	Feb. 26.	Wachusett Reservoir.

No.	LOCATION AND DESCRIPTION.	Former Owners.	Recorded.	Purpose of Taking.
29	Medford (corner Myrtle Street and Amaranth Avenue). Area, 2.10 acres in fee.	James W. Tufts.	1898. May 10.	Glenwood pipe yard.
30	Clinton, Sterling and Boylston. Area, 1,227.54 acres in fee.	Lancaster Mills *et al.*	May 20.	Wachusett Reservoir.
31	Boston, Orient Heights, Breed's Island. Area, easements in 0.42 acre.	Boston Land Company *et al.*	May 14.	Pipe line.
32	Clinton and Boylston. Area, 307.13 acres in fee.	Herman Kanis *et al.*	May 20.	Wachusett Reservoir.
33	Newton (opposite St. James Street, from Charlesbank Road to Metropolitan Park Reservation). Area, easements in 0.06 acre.	Albert Brackett.	June 20.	Pipe line.
34	Clinton (west of South Main Street). Area, easements in 0.48 acre.	Ann Maria, Owen and Patrick Kittredge, Edward and Alice G. Garrity.	June 20.	Temporary way.
35	Boylston, Clinton and Sterling. Area, 1,034.57 acres in fee.	George W. Ball *et al.*	June 20.	Wachusett Reservoir.
36	Boston (Reservoir Lane). Area, easements in 0.07 acre.	Boston & Albany Railroad.	June 27.	Pipe line.
37	Brookline (Reservoir Lane). Area, easements in 0.21 acre.	Boston & Albany Railroad *et al.*	June 27.	Pipe line.
38	Clinton and Lancaster. Area, 104.12 acres in fee; easements in 1.76 acres.	Wm. E. Fyfe *et al.*	Aug. 29.	Clinton Sewerage System.

(12) Claims for Damages to Business.

Under the Metropolitan Water Act, any individual or firm owning, on April 1, 1895, an established business on land in the town of West Boylston, is permitted to claim damages, if such business is injured by the carrying out of the Act by reason of loss of custom or otherwise. By chapter 445 of the Acts of the year 1897, the benefits of this provision were extended to individuals or firms owning such business on real estate situated in that part of the town of Sterling on the southerly and westerly sides of Stillwater River; and by chapter 551 of the Acts of the year 1898 its benefits were extended to individuals and firms in Boylston, to the same extent as in West Boylston.

Under the above provisions, 82 claims have been filed up to December 31, 1898, for injuries to established business. Settlement has been effected in 21 cases, and the sum of $19,725 has been paid to the several parties whose claims have been allowed. The claims of two applicants have been disallowed, as not entitled to the benefit of the provision. The remainder of the claims have been investigated, and offers have been made in 40 cases, in which no agreement has yet been reached.

(13) *Claims for Loss of Employment.*

By chapter 450 of the Acts of the year 1896 it was provided that any resident of the town of West Boylston, employed by any corporation, partnership or individual at the time when the plant of such corporation, partnership or individual was taken and work therein stopped on account of the Metropolitan Reservoir, and who was obliged by such taking to seek employment elsewhere, might recover the actual damages which he had suffered by reason of such loss of employment; such damages, however, not to exceed the sum of his wages for six months, at the rate paid to him for the six months prior to his loss of employment. The closing of the Rice Mills and the discontinuance of branches of work in some of the other mills and establishments have caused the filing of a considerable number of claims for loss of employment during the past year. Such claims, to the number of 65, have, up to December 31, 1898, been received, and settlements have been made in 35 cases, the sums paid to the employés settled with aggregating the amount of $6,949.68. Claims to the number of 6 have been disallowed, and offers have been made in 5 others, upon which no agreement has been reached.

(14) *Claims for Depreciation of Real Estate.*

It is also provided by the Metropolitan Water Act that the owner of any real estate not taken, but directly or indirectly decreased in value by the Act or the taking of the Board thereunder, situated in the town of West Boylston or in that portion of the town of Clinton near the proposed reservoir on either side of River and Grove streets, may receive damages on account of such decrease in value. By chapter 445 of the Acts of the year 1897 the privileges of this provision were extended to owners of real estate in the town of Sterling, situated on the southerly and westerly sides of the Stillwater River. The Board has found it a matter of great difficulty to determine in advance in any satisfactory manner the extent to which such property will be decreased in value by the operations of the Board. The problem is made more difficult, because it has not been possible as yet to fix, except for a limited territory, the exact margins of the reservoir; nor has it been possible to determine the location of all of the roads which will take the place of existing roads, or to enter upon any agreement in regard to the relocation of the Central Massachusetts Railroad. Consequently, little progress has been made toward the settlement of these claims; and the Board has felt that it is not only wiser for the Commonwealth, but more just to the people concerned, in most cases to delay somewhat longer reaching a determination, in the expectation that some, at least, of these problems may be solved before the time has expired within which suits must be brought.

III. Work of Maintenance.

(1) Operation of Works.

The Metropolitan Water Act provided that the Board should, on or before January 1, 1898, commence the operation of the works taken by it from the city of Boston, and thereafter should maintain and operate the same, together with such water works as should be constructed by it, for the supply of the Metropolitan Water District.

Accordingly, the Board has operated during the entire year the works so taken from the city of Boston, being in general the Cochituate Lake and Aqueduct, with the Pegan filter-beds, the Framingham reservoirs and the Ashland and Hopkinton reservoirs, the Sudbury Aqueduct, the Chestnut Hill Reservoir and pumping station, and the Mystic distributing reservoir; and has also included in its operations Spot Pond, which was taken from Malden, Medford and Melrose, with the Melrose pumping station. The Mystic works, with the exception of the distributing reservoir, have not been kept in operation since the taking from Boston, owing to the unfit quality of the water for domestic purposes.

The Board has, since the actual diversion of the water of the Nashua River, on March 7, 1898, also operated the Wachusett Aqueduct and the Sudbury Reservoir.

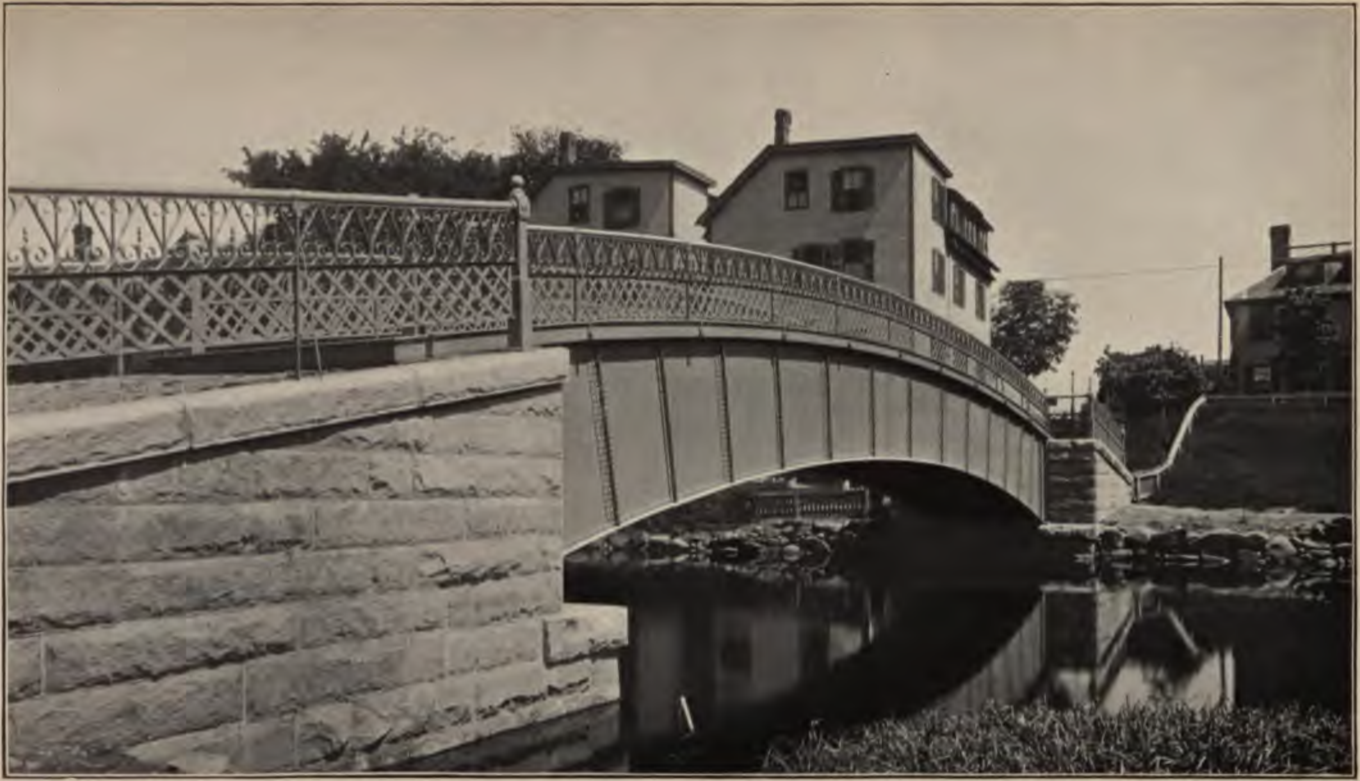
By means of the various main pipe systems which had been constructed by the Board, the supply of water which was received at the Chestnut Hill Reservoir and at Spot Pond has been conveyed to the cities and towns in the Metropolitan District, the various municipalities receiving the water at some point in their local system, and themselves distributing it to their respective communities.

Water has thus been delivered to all the cities and towns originally embraced in the district, except Newton and Hyde Park, by which no applications were made for a water supply. In addition, Quincy, which had been admitted later into the district, began to receive water at the end of the year.

The Board felt that it was called upon to give the benefit of the water supply to all the cities and towns in the Metropolitan Water District at as early a date as possible, and to as great an extent as practicable from the works acquired and from its other works in process of construction. It was obviously not possible, at the very beginning of the year 1898, for the Board to give the full service contemplated by the Metropolitan Act; and it could not at once supply from the Metropolitan Water Works, at the required pressure for use without pumping, every portion of every city and town in the district, or at the outset even to supply at all some of the cities and towns included. It has, however, so advanced its works and completed such arrangements during the year that it will be able to give during the coming year a substantially complete service to the various cities and towns in the district desiring water, except Nahant, which was admitted during the year, and Swampscott, which, though outside of the district, is to be supplied with water. These towns will, however, be at an early date in the year connected with the main pipe lines, and receive a water supply from the Metropolitan Works. It is anticipated that both Newton and Hyde Park will during the year continue to be supplied from their own systems.

In order to give water at the required pressure to certain of the higher districts, it has been necessary that arrangements should be made by which the cities of Malden, Chelsea, Somerville and Medford should temporarily use their own pumping stations for supplying certain high districts, not only within their own limits but in other parts of the district, the expense of the operation of the stations being paid for by the Board.

It is anticipated that the Board will be able to complete the high-service reservoir in Middlesex Fells and the pumping station at Spot Pond so as to be able by the end of the year 1899 to perform the entire service in the northern district. There is a small district in West Roxbury in which water cannot yet be supplied from the Metropolitan Works at the required pressure; but arrangements



BRIDGE SUPPORTING MAIN WATER PIPES ACROSS MYSTIC RIVER IN MEDFORD.

for a series of years have been made with the city of Boston, by which the Board is to assume the operation of a small pumping station situated near Mt. Bellevue, belonging to the city, by which the proper supply will be furnished.

(2) *Sanitary Inspection and Regulations.*

The sanitary inspection maintained by the city of Boston over the Cochituate and Sudbury watersheds has been continued, and many cases of pollution have been remedied. Fifty-three cases have been remedied by sewer connection and 4 by other means, while 38 other cases have been partially remedied, and 51 cesspools have been superseded by sewer connection.

The system of inspection has been extended to the Nashua watershed, and the various sources of pollution have been investigated and steps taken for their abatement. Seventy-two cases of pollution from mills, dwellings and other buildings have been abated.

The camps of the contractors, wherever work has been carried on, have been constantly visited by medical inspectors, in order to insure suitable sanitary condition and prevention from infectious diseases. Any serious cases of illness have been removed at once to the Clinton Hospital.

The State Board of Health is authorized and required by the Metropolitan Water Act to make rules and regulations for the sanitary protection of all waters used by the Metropolitan Water Board for water supply. In accordance with this provision, application has been made to the State Board of Health for the adoption of such rules and regulations.

Prior to the adoption of rules by the Board of Health, it was deemed wiser during the year to make somewhat stringent regulations as to bathing, boating and fishing, in such portions of the reservoirs as came into more immediate relation with the water supply. While it would be necessary to continue very stringent regulations in regard to those basins which are used more immediately as distributing reservoirs for such of the waters as will be conveyed for use in the Metropolitan District, it is probable that, after the publication of the rules of the Board of Health, some relaxations as to the regulations, especially as to the privileges of fishing, may be made in the case of the reservoirs which are more remote, or from which the supply will not be regularly taken. It is not the policy of the Board to adopt any restrictive regulations relative to Whitehall Pond and Farm Pond, and it is not proposed to curtail the privileges of boating which have hitherto been enjoyed by the residents upon Lake Cochituate.

(3) *The Year's Water Supply.*

The supply of water from the various sources of the Metropolitan System during the year was unusually large, owing to the abundant rainfall. The rainfall in the Sudbury watershed for the year was 55.88 inches, being 9.69 inches more than that of the average year, and 23.10 inches more than that of the dry year of 1883. The supply of water afforded by this watershed in the year 1898 was more than one-third greater than that of the average year, and nearly three times as large as that of the year 1883; while the supply of the watershed for the driest six months of the year was two-thirds more than that of the average year, and more than five times that of the year 1883.

(4) *Consumption of Water.*

The average daily consumption of water in the various cities and towns comprising the Metropolitan Water District, which were supplied during the year wholly or in part by the Metropolitan Water Works, was 79,274,000 gallons, — an equivalent to 103 gallons a day for each inhabitant of the district supplied. Of this quantity, 76,081,000 gallons per day were supplied by the Metropolitan Works, and 3,193,000 gallons from local sources. This consumption per inhabitant is 13 per cent. in excess of that of four years ago, in 1894, or an increase in four years of 12 gallons for each inhabitant. During the colder weather the consumption of water is greatly increased, sometimes amounting to more than 50 per cent. in excess of the average consumption. The great yearly increase in the consumption of water per inhabitant which has been going on for several years, and especially the excessive increase at certain periods, calls for serious consideration. It is beginning to be realized by the larger cities of the country that there is an undue and an unreasonable use, or rather misuse, as well as waste, of water; and this constant increase, if not checked, will demand the taking of stringent measures for its prevention. While every attempt is properly made to insure the supply reasonably required for all domestic, manufacturing and public uses, the misuse and waste of water and the consequent call for an undue expenditure of money, as well as for unnecessarily high water rates, will require a careful investigation and proper measures of prevention.

(5) *Quality of Water.*

The quality of the water furnished to the larger portion of the Metropolitan District has much improved during the year, as appears from the examinations and analyses which have been constantly made.

During the early part of the year the water was chiefly furnished from the Sudbury system. That which was supplied from Lake Cochituate was, owing to the growths of certain disagreeable but not unwholesome organisms, of unsatisfactory character, and as little as reasonably possible was drawn from that source.

The water supplied from Spot Pond was also of inferior quality, owing to the present unsatisfactory character of the pond as a storage reservoir; so that the water which at times was supplied from this source, especially to certain of the cities and towns in the northern portions of the district, was not always of a satisfactory taste and color, although not unwholesome.

The Nashua water, which the Board has been enabled to supply during the latter and larger portion of the year, has been of a decidedly superior quality; although the water from this source is not so good as it is expected to be after the completion of the great storage facilities which will be afforded by the Wachusett Reservoir, and the important improvements which will be made in the watersheds. The contemplated improvement of Spot Pond will also greatly improve the character of the water which will be drawn from and through that reservoir.

(6) *Abandonment of Mystic Water Works.*

The Mystic Water Works, which were originally constructed by the city of Charlestown, and upon its annexation became the property of the city of Boston, were included in the takings made on January 1, 1898.

The supply of water from the Mystic system was obtained from the Upper Mystic Lake, which had a watershed with an area of 27.75 miles. The capacity of this source was estimated to be 7,000,000 gallons per day in a very dry year, and in 1883 this proved to be about its actual capacity.

The works included, in addition to the Mystic Lake, at which a considerable dam had been built, an aqueduct, a pumping station, containing four engines with a combined capacity of 28,500,000 gallons per day, and a distributing reservoir on College Hill in Medford, to which the water was pumped.

The Mystic water had been supplied to the Charlestown district, and also, under contracts made with the city of Boston, to the cities of Somerville, Chelsea and Everett, as well as at certain periods to East Boston.

The watershed includes not only many manufacturing establishments, but a dense population, the number of inhabitants per square mile exceeding 1,000.

A report to the State Board of Health, made in the year 1874, discussed the various causes of pollution which served to contaminate this as a source of water supply, and various suggestions were made as to methods for its purification and improvement.

In the year 1874, just after the Mystic had been acquired by the city of Boston, a medical commission, consisting of Doctors Charles W. Swan, Edward S. Wood and H. P. Bowditch, appointed by the city of Boston to examine and report upon the comparative desirability, on sanitary grounds, of the Mystic, Sudbury, Shawshine and Charles River waters, made an extended report, by which it was shown that the Mystic was then the least desirable of the four in all sanitary qualities, considered in reference to color, taste and general appearance, chemical analyses, opportunities for storage, and in its sources of pollution from manufacturing refuse, both actual in the present, and probable for the future. The Mystic River, on account of the dense population in its valley and its inferior storage facilities, was further declared to be, without reference to the direct sources of pollution, much less desirable than the other rivers as a source of water supply.

Mr. M. S. Greenough, for three years chairman of the water committee of the city council of the city of Boston, declared, in the hearing in 1883 on the question of taking the waters of the Shawshine: "The Mystic system, in my judgment, has got to be abandoned before any great number of years, no matter what we do to-day."

In the year 1887, at a hearing on the same question, Mr.

Jackson, the city engineer, said that, from present indications, he thought it imperative for the city soon to discontinue the Mystic supply.

Repeated references have been made in the reports of the Boston Water Board to the unsatisfactory character of this source of supply.

Mr. Wightman, city engineer, in his report for the year 1884, said: "On the Mystic, situated as it is in a thickly populated valley, the elimination of sewage from the feeders of the lake is practically impossible; and, although much has been and may yet be done to preserve the purity of the supply, it is evident that it must before many years be abandoned."

The Boston Water Board, in discussing the sources of pollution to the Mystic, in their annual report for the year ending December 31, 1885, declared: "The conclusion is forced upon us that a substitute for the Mystic must soon be obtained."

Mr. Jackson, the city engineer, in 1886 says: "It is only by constant and careful attention that it [the Mystic water] can be kept comparatively pure, and it is certain to constantly deteriorate in quality."

The Water Board, in the year 1887, says, in reference to the Mystic supply: "We not only can expect no improvement, but must anticipate a gradual deterioration." And Mr. Jackson says, in the same year, in his report: "The water from the Mystic supply is constantly deteriorating, although constant efforts have been made to protect its sources from pollution."

The State Board of Health has also continued to call attention to the unsatisfactory quality of the Mystic supply, and in their report of 1895, which recommended the scheme of the Metropolitan Water Act, assumed that the Mystic supply would cease to be used for domestic purposes under the Act.

The investigations regarding the Mystic water, instituted by the Board, confirmed the statements which had been made regarding the unfitness in quality of the Mystic water for domestic uses; and accordingly, on taking the water works of the city of Boston, on January 1, 1898, it discontinued the operation of the Mystic works, and none of this water has been supplied by the Board to the Metropolitan District.

A portion of the pumping engines at the Mystic station will be kept in commission, so that, in case of emergency, the water could be drawn from the Mystic Lake. The Mystic Reservoir, however, on College Hill, is connected with the main pipe system, and will be of considerable service as a small distributing reservoir.

The following is a summary of the purposes of the expenditures for maintenance and operation: —

	For the Year ending Dec. 31, 1898.	From Beginning of Work, and ending Dec. 31, 1898.
Temporary dam and gate-house, and the Wachusett Aqueduct from Clinton to Southborough, .	$6,046 38	$6,046 38
The Sudbury, Ashland, Hopkinton, Framingham, Lake Cochituate and other reservoirs, the Sudbury and Cochituate aqueducts, the Pegan Brook filters, the biological laboratory and other work in the Sudbury system, . . .	57,178 31	57,178 31
Pumping at Chestnut Hill, Spot Pond and elsewhere, care of reservoirs and pipe lines, and other work in the distribution system, . .	82,983 31	82,983 31
Administration, supervision, taxes and other general expenses, ...	11,979 31	11,979 31
Totals, ...	$158,187 31	$158,187 31

IV. ADMISSION OF OTHER MUNICIPALITIES INTO THE METROPOLITAN WATER DISTRICT.

The town of Nahant was, upon its application, admitted into the Metropolitan Water District on September 13, 1898. Extended investigations were required, in order to ascertain the best methods of supplying water to that town; and it was determined, instead of laying the pipe across Nahant Bay, to extend a main pipe line from Revere, through Saugus and Lynn, to Nahant, the pipe for the greater portion of the way being laid over the old Lynn turnpike, so-called, and connecting at Nahant with the main pipe now supplying the town from Swampscott. Owing to the building of a new bridge across the Saugus River, to accommodate the Lynn & Boston Street Railway Company, it was impossible to complete the line during the past season; but it is expected that it will be completed in the spring, and that water will then be supplied to the town of Nahant, as to the rest of the district.

The town was required to pay to the Commonwealth, on admission, the sum of $20,000, and is required in addition to make a payment of $800 on the first day of May in each year, beginning with the first day of May in the year 1899, until such time as the town of Swampscott shall begin to purchase water from the Metropolitan Water Works, or shall enter the Metropolitan Water District; such annual payment to be in addition to the annual assessment provided for by the terms of the Metropolitan Water Act. It was provided that the Board may put into the pipe a pressure regulating valve, reducing the pressure beyond the valve to that due to a head of 200 feet above Boston City Base; and also that the pipe line laid for the supply of Nahant may be used for the supply of Swampscott and other communities, to the extent that it can be so used without reducing the pressure beyond the valve, during the daytime and on ordinary occasions, below that due to the 200 feet head aforesaid.

The town of Swampscott, being situated beyond the ten-mile limit prescribed in the Act to entitle it to admission into the Metropolitan Water District, made application under the provisions of the Act for water to be furnished to that town. Accordingly, an agreement was entered into on December 2, 1898, by which it was stipulated that the Board shall furnish water to the town from as early a date as it shall be able to supply the same, and until December 31, 1908, the water to be furnished through a main pipe, under similar conditions to those prescribed in the case of the town of Nahant; in consideration of which the town of Swampscott paid to the Commonwealth the sum of $20,000, and agreed to make annual payments on or before the first day of May in each year of the following sums: 1899, $1,500; 1900, $2,000; 1901, $2,500; 1902, $3,000; 1903, $3,500; 1904, $4,100; 1905, $4,600; 1906, $4,800; 1907, $4,800; 1908, $4,800; except that the town shall not be required to make any annual payment until after the first day of the month succeeding that on which the Metropolitan Water Board begins to furnish water to the town, and that there shall be deducted one-twelfth of the assessment for the current calendar year for each full calendar month which shall elapse after December 31, 1898, before the Board begins to furnish water. As the water is to be furnished to the town of Swampscott by the pipe which is laid to supply the town of Nahant, no water will be furnished until the spring of 1899.

The town of Arlington made formal application for admission into the district on November 28, 1898, and arrangements have nearly been completed for the admission of that town.

V. FINANCIAL STATEMENT.

(1) *Receipts from Water Loans and Other Sources.*

The total receipts, on account of the Metropolitan Water Act, to December 31, 1898, amount, exclusive of premiums, to $17,068,181.14. These receipts, together with the fund available on January 1, 1899, are as follows: —

From sale of bonds,	$17,000,000 00
From the town of Nahant on admission to District,	20,000 00
From the town of Swampscott on account of supplying water,	20,000 00
From rents, real estate and miscellaneous sources,	28,181 14
	$17,068,181 14
Amount approved for payment by Board to December 31, 1898,	16,022,418 85
Balance January 1, 1899,	$1,045,762 29

If to this balance is added the sum of $98,423.25 for bills, pay rolls, etc., sent to the Auditor in December, but not placed by him on warrants for payment until January, 1899, and the further sum of $286.48 ready for payment but not yet called for; and from the amount is deducted $2,594.34, not received by the Treasurer until January, 1899, the result will be $1,141,877.68, which is the balance reported available in the treasury on January 1, 1899.

The Treasurer of the Commonwealth was authorized by the Metropolitan Water Act to issue from time to time, on the request of the Board, negotiable bonds, in the name and behalf of the Commonwealth, to an amount not exceeding $27,000,000, such bonds to be designated the "Metropolitan Water Loan," and to be payable in not less than thirty years nor more than forty years.

The following is a statement of the bonds sold by the Treasurer to December 31, 1898: —

DATE.	Bonds Sold.	Rate.	Premiums.
1895,	$2,225,000	$1 1067	$237,407 50
1896,	2,775,000	1 1067	296,092 50
1896,	2,000,000	1 0676268	135,253 60*
1897,	6,000,000	1 0782	469,200 00
1898,	2,000,000	1 13176	263,520 00
1898,	2,000,000	1 12877	257,540 00
	$17,000,000		$1,659,013 60

* Including $18,673.60 from readjustment of rate made by Treasurer in 1897.

The Treasurer of the Commonwealth was required to establish a sinking fund sufficient, with its accumulations, to extinguish the bonded debt at maturity. To this sinking fund there is required to be paid the premiums from the sales of the bonds and the proceeds from the operations of the Board, exclusive of those arising from sales of property, and such further amounts as he may deem necessary for the payment of interest and the payment of principal at maturity.

The sinking fund so established amounted at the end of each year to sums as follows: —

Dec. 31, 1895,	$226,286 05
Dec. 31, 1896,	699,860 70
Dec. 31, 1897,	954,469 00
Dec. 31, 1898,	1,416,374 29

For the payment of the interest on the bonds issued by the Commonwealth, the sinking fund requirements and the expenses of maintenance and operation of the water works, annual assessments are made upon the various cities and towns constituting the Metropolitan Water District. There is apportioned each year to the city of Boston such amount as the valuation of that city of the preceding year bears to the valuation of all the cities and towns in the district; except that there is included in the amount of such valuations only one-sixth of the total valuation of any city and town which has not reached the safe capacity of its sources of supply in a dry year, as determined by the Water Board, and has not made application to the Board for water. The remainder to be raised is assessed to the other cities and towns in the district, one-third in proportion to their respective valuations, and two-thirds in proportion to their respective populations, including, however, only one-sixth of the total valuation and one-sixth of the total population of any city or town which has not reached the safe capacity of its sources of supply, or has not made application for water as aforesaid. A city or town, however, which is assessed on its full valuation and population, and which furnishes a part of its water supply from its own works, or receives a supply from a water company, is allowed and credited in its apportionment with a sum equal to $12 for each 1,000,000 gallons of water so furnished, as determined by the Board. It was, however, provided by the Act that no such amount should be apportioned until the year 1898; and, in that year, that the amount of $300,000 only, together with such sums as had been expended by the State Board of Health in its investigations of a water supply for the Metropolitan District, should be assessed. The total sum assessable, therefore, for the year 1898, was $342,500.

In each succeeding year the amount to be so assessed is to be increased by $200,000, until the entire amount required for the payment of interest, sinking fund requirements and expenses of maintenance and operation is reached, and thereafter such entire sum so required is to be so apportioned.

In the assessments of the year there was allowed to certain of the cities and towns, at the rate of $12 for each 1,000,000 gallons, for water furnished from their own works or received from water companies from January 1 to May 31, 1898, amounts as follows: —

Malden, ...	$450 60	Watertown, ...	$612 96
Medford, ...	1,788 36	Winthrop, ...	493 30
Quincy, ...	2,269 44		
Belmont, ...	204 36	Total, ...	$6,692 52
Revere, ...	873 50		

The net sums assessed, in accordance with the provisions of the Act, by the Treasurer of the Commonwealth upon the various cities and towns of the district, for the year 1898, were as follows: —

Boston, ...	$285,600 54	Belmont, ...	$711 38
Chelsea, ...	7,874 03	Hyde Park, ...	506 12
Everett, ...	4,795 37	Melrose, ...	3,332 94
Malden, ...	7,361 47	Revere, ...	1,362 36
Medford, ...	2,579 98	Watertown, ...	1,730 22
Newton, ...	1,654 86	Winthrop, ...	841 51
Quincy, ...	3,206 51		
Somerville, ...	14,250 19	Total, ...	$335,807 48

The smaller sums assessed upon the city of Newton and the town of Hyde Park were owing to the fact that neither of these municipalities had reached the safe capacity of its sources, and consequently neither had made application for water.

(2) *General Statement of Expenditures.*

The following is a summary of the expenditures made by the Board in its various operations: —

Summary of Expenditures.

		For the Year ending Dec. 31, 1898.	From Beginning of Work, and ending Dec. 31, 1898.
Construction.			
Wachusett Dam, Reservoir and Watershed, . . .		$702,583 68	$2,468,640 64
Wachusett Aqueduct, ...		190,248 59	1,713,404 70
Sudbury Dam, Reservoir and Watershed, ...		239,077 76	2,916,067 18
Pipe line and connections between Framingham Dams No. 3 and No. 1, ...		32,822 63	48,465 47
Pipe lines across Rosemary valley, ...		23,034 05	23,034 05
Distribution system, ...	$688,987 03		2,476,852 61
Less value of pipes, valves, etc., purchased and sent to store yards in previous years, but transferred to works, and included in cost of same for the current year, . .	129,578 36	559,408 67	
Other work and operations: —			
Investigations of existing water works systems, and payments on account of same, ...		5,035,045 15	5,041,692 72
Settlements on account of diversion of water and expenses connected with the same, including Clinton sewerage system, ...		91,179 83	930,824 34
Administration and general expenses, ...		25,085 62	98,125 49
Pipes, valves, etc., sent to store yards and not yet transferred to works, ...		-	147,124 34
		$6,898,485 98	$15,864,231 54
Maintenance.			
Dam and aqueduct department, ...		$6,046 38	$6,046 38
Sudbury department, ...		57,178 31	57,178 31
Distribution department, ...		82,983 31	82,983 31
Administration, general supervision and taxes, . . .		11,979 31	11,979 31
		$158,187 31	$158,187 31
Total expenditures, ...		$7,056,673 29	$16,022,418 85

(*3*) *Detailed Financial Statement.*

The Board herewith presents, in accordance with the Metropolitan Water Act, an abstract of its expenditures and disbursements, receipts, assets and liabilities, for the year 1898.

(*a*) EXPENDITURES AND DISBURSEMENTS. — The total amount of the expenditures and disbursements for the year beginning January 1, 1898, and ending December 31, 1898, is $7,056,673.29, and the total amount from the time of the organization of the Board, July 19, 1895, to December 31, 1898, is $16,022,418.85. The following is a *division of the expenditures according to their general character.*

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending Dec. 31, 1898.		From Beginning of Work, and ending Dec. 31, 1898.	
Administration.				
Commissioners,	$11,600 00		$46,310 27	
Secretary and auditor,	4,900 00		19,173 13	
Clerks and stenographers,	4,339 21		14,601 53	
Legal services,	25 00		2,359 00	
Travelling,	427 60		910 82	
Stationery and printing,	915 39		3,455 71	
Postage, express and telegrams,	379 90		860 01	
Furniture and fixtures,	250 19		3,135 98	
Alterations and repairs of building,	701 55		2,405 29	
Telephone, lighting, heating, water, and care of building,	1,260 32		3,467 22	
Miscellaneous expenses,	286 46	$25,085 62	1,446 53	$98,125 49
Engineering.				
Chief engineer and department engineers,	$21,403 33		$70,644 41	
Principal assistant engineers,	15,466 74		49,063 61	
Engineering assistants,	113,734 75		346,987 15	
Consulting engineers,	7,090 00		17,451 10	
Inspectors,	15,166 57		89,307 90	
Architects,	6,208 25		8,429 61	
Railroad and street car travel,	4,322 35		11,313 42	
Wagon hire,	3,200 66		10,808 28	
Stationery and printing,	3,103 85		10,881 54	
Postage, express and telegrams,	868 34		2,819 56	
Engineering and draughting instruments and tools,	529 95		14,069 17	
Engineering and draughting supplies,	2,562 93		12,021 23	
Books, maps and photographic supplies,	871 63		3,005 61	
Furniture and fixtures,	1,494 87		11,145 22	
Alterations and repairs of building, main office,	731 49		3,113 96	
Alterations and repairs of building, sub-offices,	55 79		471 63	
Telephone, lighting, heating, water, and care of building, — main office,	2,105 39		5,042 17	
Telephone, lighting, heating, water, and care of building, — sub-offices,	1,913 86		5,837 95	
Rent of offices and other buildings,	332 75		2,335 28	
Field offices and sheds,	86 00		702 64	
Clinton office building,	-		9,866 87	
Unclassified supplies,	381 39		4,188 14	
Miscellaneous expenses,	1,228 79		4,723 58	
Reimbursement, city of Boston,	-	202,859 68	69,918 69	764,148 72
Amounts carried forward,	. . .	$227,945 30		$862,274 21

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending Dec. 31, 1898.		From Beginning of Work, and ending Dec. 31, 1898.	
Amounts brought forward, . .	. . . .	$227,945 30		$862,274 21
Construction.				
Preliminary work (borings, soundings, test pits and other investigations): —				
Advertising, ...	$650 59		$2,624 59	
Labor, ...	21,551 77		71,335 26	
Medical services, analyses, etc., .	76 00		621 33	
Travelling, ...	3 50		1,460 88	
Rent, ...	3 00		37 00	
Water rates, ...	119 17		2,077 30	
Freight and express, . . .	17 31		391 35	
Jobbing and repairing, . . .	82 09		404 67	
Tools, machinery, appliances and hardware supplies, . . .	499 46		14,949 45	
Castings, ironwork and metals, .	32 87		120 14	
Iron pipe and valves, . . .	70 89		2,925 11	
Blasting supplies, ...	5 13		36 73	
Paint and coating, ...	2 71		138 54	
Fuel, oil and waste, . . .	88 99		547 93	
Lumber and field buildings, . .	159 78		4,786 26	
Drain pipe, ...	40 80		40 80	
Brick, cement and stone, . .	55 00		223 19	
Sand, gravel and filling, . .	-		195 05	
Municipal and corporation work, .	4 00		44 07	
Unclassified supplies, . . .	149 23		1,067 65	
Miscellaneous expenses, . .	97 39		209 69	
Reimbursement, city of Boston, .	-	23,709 68	55,404 63	159,641 62
Contracts, Wachusett Reservoir: —				
Joseph D. Gennaro, . Sect. 1,	$2,582 59		$11,870 95	
Neill McBride, . . Sect. 2,	2,815 39		12,067 11	
T. H. Riddle & Co., . Sect. 3,	38,719 06		38,719 06	
Neill Devine & Co., . Sect. 4 (in part),	3,450 11		3,450 11	
Newell & Snowling Construction Co., ... Sect. 4 (in part),	6,052 22		6,052 22	
Joseph D. Gennaro, . Sect. 4 (in part),	16,248 81		16,248 81	
Moulton & O'Mahoney, . Sects. 4 and 6 (in part),	9,884 56	79,752 74	9,884 56	98,292 82
Contracts, Wachusett Aqueduct: —				
E. D. Smith & Co., . Sect. 2,	$19,911 91		$128,720 11	
E. D. Smith & Co., . Sect. 3,	37,887 96		242,601 06	
Amounts carried forward, . .	$57,799 87	$331,407 72	$371,321 17	$1,120,208 65

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending Dec. 31, 1898.		From Beginning of Work, and ending Dec. 31, 1898.	
Amounts brought forward, . .	$57,799 87	$331,407 72	$371,321 17	$1,120,208 65
Construction — Con.				
Contracts, Wachusett Aqueduct — *Con.*				
Silvio Casparis, . . Sect. 4,	793 72		114,167 77	
Silvio Casparis, . . Sect. 5,	969 57		98,679 99	
Silvio Casparis, . . Sect. 6,	22,959 04		145,453 49	
Silvio Casparis, . . Sect. 7,	81 37		128,802 72	
Jones, Pollard & Co., . Sect. 8,	66 70		64,766 00	
Silvio Casparis, . . Sect. 9,	-		171,041 07	
Silvio Casparis, . . Sect. 10,	190 78		170,252 02	
Moulton & O'Mahoney, . Sect. 11,	36,560 81		143,642 77	
W. A. Murtfeldt Co., covering Assabet Bridge, ...	-		1,261 00	
J. W. Bishop & Co., superstructure terminal chamber, . . .	639 00		4,260 00	
New England Granite Works, superstructure gaging man-hole,	1,584 00	121,644 86	1,584 00	1,415,232 00
Contracts, Sudbury Reservoir: —				
Moulton & O'Mahoney, Sudbury Dam, ...	-		$297,482 60	
Auguste Saucier, . . Sect. A,	$29,033 08		62,183 11	
Moulton & O'Mahoney, . Sect. B,	-		55,477 93	
Malone & Strang, . . Sect. C,	-		81,070 83	
Auguste Saucier, . . Sect. D,	-		41,567 41	
Charles Linehan, . . Sect. E,	-		32,802 86	
Newell & Snowling, . Sect. F,	-		26,272 55	
Charles Linehan, . . Sect. G,	-		16,738 23	
Moulton & O'Mahoney, . Sect. H,	-		34,486 72	
Harry P. Nawn, . . Sect. I,	-		70,343 26	
Moulton & O'Mahoney, . Sect. J,	-		43,754 13	
Blagen & Bush, . . Sect. K,	2,195 02		56,167 62	
Moulton & O'Mahoney, . Sect. L,			78,864 00	
Harry P. Nawn, . . Sect. M,	16,319 41		107,879 43	
Thomas Nevins & Son, . Sect. N,			55,227 98	
Washburn & Washburn, Sect. O,	47,258 87		119,877 60	
Sundry bills paid under this contract, ...	933 51		933 51	
Harry P. Nawn, . . Sect. P,	14,719 71		86,430 70	
Washburn & Washburn, Sect. Q,	7,651 14		106,163 80	
Mignault & McGrain, Spillway Channel, ...	988 08		988 08	
S. D. Hicks & Son, changing gutter, etc., at gate-house, . . .	275 00		275 00	
Amounts carried forward, . .	$119,373 82	$453,052 58	$1,374,987 35	$2,535,440 65

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending Dec. 31, 1898.		From Beginning of Work, and ending Dec. 31, 1898.	
Amounts brought forward, . .	$119,373 82	$453,052 58	$1,374,987 35	$2,535,440 65
Construction — Con.				
Contracts, Sudbury Reservoir — *Con.*				
Henry Parsons, iron fence, . .	-		16,342 96	
John Berry, filter beds, . . .	-		896 79	
Mignault & McGrain, settling reservoir, ...	2,380 45		2,380 45	
Holbrook, Cabot & Daly, stone arch bridge, ...	-		33,400 21	
N. Y., N. H. & H. R.R. Co., temporary bridge, ...	-		6,387 80	
R. D. Wood & Co., sluice gates, .	-		4,918 06	
J. W. Bishop & Co., gate-house, .	-		17,437 92	
John Evans & Co., granite finial, .	-		350 00	
Holbrook, Cabot & Daly, circular dam, ...	-		4,550 27	
Reimbursement, city of Boston, .	-	121,754 27	461,089 26	1,922,741 07
Contracts, Rosemary Siphon: —				
A. L. Norton & Co., pipe-laying, .	$4,194 04		$4,194 04	
Sundry bills paid under this contract, ...	787 49		787 49	
T. Tighe & Sons, teaming pipe, .	930 33	5,911 86	930 33	5,911 86
Contracts, Pipe Line, Dam No. 3 to Dam No. 1: —				
Harry P. Nawn, pipe-laying, .	$2,707 60		$15,269 27	
L. F. Childs, teaming pipe, . .	1,970 95	4,678 55	1,970 95	17,240 22
Contracts, Clinton Sewerage System: —				
Newell & Snowling Construction Co., ... Sect. 1,	$15,613 19		$15,613 19	
O. Cunningham & Son, . Sect. 2,	10,041 15		10,041 15	
Sundry bills paid under this contract, ...	4,202 17	29,856 51	4,202 17	29,856 51
Contracts, distribution system: —				
Malone & McHale, . Sect. 1,	$4,072 33		$6,867 63	
Curnan & Hochstader, . Sect. 2,	-		39,517 92	
MacRitchie & Nichol, . Sects. 3 and 10,	9,883 20		40,507 71	
C. A. & C. E. Trumbull, Sect. 4,	1,598 70		6,741 42	
Snyder & Williams, . Sects. 4 and 11,	-		48,469 33	
MacRitchie & Nichol, . Sect. 5,	9,544 33		44,066 34	
Amounts carried forward, . .	$25,098 56	$615,253 77	$186,170 35	$4,511,190 31

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending Dec. 31, 1898.		From Beginning of Work, and ending Dec. 31, 1898.	
Amounts brought forward, . .	$25,098 56	$615,253 77	$186,170 35	$4,511,190 31
Construction — Con.				
Contracts, distribution system — *Con.*				
Moore & Co. & W. H. Ward, Sect. 6,	4,660 12		9,448 65	
Dennis F. O'Connell, . Sect. 6,	-		16,644 84	
C. H. Eglee Co., . . Sects. 6 and 8,	300 00		61,681 92	
C. H. Eglee Co., . . Sects. 7 and 13,	111 36		34,054 41	
E. W. Everson & Co., . Sect 9,	2,988 11		17,750 30	
Bruno & Salomone, . Sect. 9,	5,971 25		5,971 25	
H. A. Hanscom & Co., . Sects. 11 and 18,	6,001 21		35,503 40	
A. W. Bryne Construction Co., Sect. 13,	620 70		26,063 89	
Collins & Ham,. . . Sect. 14,	-		11,759 81	
J. H. McKnight, . . Sect. 15,	-		11,966 06	
George Goodhue, . . Sect. 16,	-		4,925 11	
H. A. Hanscom & Co., . Sect. 16,	1,280 19		2,447 12	
H. A. Hanscom & Co., . Sect. 17,	-		2,534 72	
Collins & Ham, . . Sect. 18,	186 00		10,868 97	
Cheney & Trumbull, . Sect. 18,	1,790 24		2,561 65	
E. W. Everson & Co., . Sect. 19,	18,008 47		36,842 54	
Bruno & Salomone, . Sect. 19,	5,788 38		5,788 38	
H. A. Hanscom & Co., . Sect. 20,	25,790 31		25,790 31	
Saucier & O'Brien, . Sect. 21,	3,523 97		13,462 66	
Bruno & Salomone, . Sect. 23,	1,430 28		9,895 24	
Samuel Frescoln, . . Sect. 24,	2,581 84		8,892 10	
E. W. Everson & Co., . Sect. 24,	5,050 36		5,050 36	
Michael Russo, . . Sect. 25,	2,663 34		2,663 34	
Mirick & Wentworth, . Sect. 26,	9,028 78		9,028 78	
O'Rourke & Nelson, . Sect. 27,	7,770 67		7,770 67	
R. D. Wood & Co., iron pipe and special castings, ...	529 44		299,806 34	
Warren Foundry and Machine Co., iron pipe, ...	37,503 09		260,457 72	
McNeal Pipe and Foundry Co., iron pipe and special castings, .	81,464 29		392,948 33	
Camden Iron Works, iron pipe, special castings and valves, .	27,149 73		331,520 10	
Addyston Pipe and Steel Co., iron pipe, ...	-		30,473 48	
Chelmsford Foundry Co , cast-iron frames and covers, . . .	-		1,841 61	
Amounts carried forward, . .	$277,290 69	$615,253 77	$1,882,584 41	$4,511,190 31

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending Dec. 31, 1898.		From Beginning of Work, and ending Dec. 31, 1898.	
Amounts brought forward, . .	$277,290 69	$615,253 77	$1,882,584 41	$4,511,190 31
Construction — Con.				
Contracts, distribution system — *Con.*				
Davis & Farnum Manufacturing Co , cast-iron frames and covers,	998 04		998 04	
Howard Harrison Iron Co., iron pipe, ...	-		156,628 28	
Coffin Valve Co., valves, . .	1,845 00		1,845 00	
Josiah H. Long, valves, . . .	-		14,008 00	
Kennedy Valve Manufacturing Co., valves, ...	1,836 00		11,390 00	
New Jersey Steel and Iron Co., steel work for valve chamber, .	-		2,132 55	
New Jersey Steel and Iron Co., pipe bridge over Mystic River, .	3,980 00		3,980 00	
Cheney & Trumbulls, pipe bridge over Mystic River, . . .	1,429 17		3,570 28	
David H. Andrews, pipe bridge over Boston & Maine Railroad, . .	-		2,497 00	
Boston Bridge Works, pipe bridge over Boston & Albany Railroad,	1,500 00		1,500 00	
Pittsburg Bridge Co., pipe bridge over Boston & Maine Railroad, .	3,097 00		3,097 00	
The E. P. Allis Co., Chestnut Hill high-service pumping engine, .	51,300 00		51,300 00	
The W. H. Gallison Co., steam piping, ...	1,400 00		1,400 00	
C. A. Dodge & Co., Addition to Chestnut Hill pumping station, .	32,400 09		45,643 59	
Edward Kendall & Sons, iron work for pumping station, . . .	3,199 32		3,199 32	
Lake Erie Boiler Works, Belpaire boiler, Chestnut Hill high-service pumping station, . . .	13,650 00		13,650 00	
Brown Hoisting and Conveying Machinery Co., hand travelling crane, ...	1,930 00		1,930 00	
Hugh Cairns, stone carving on pumping station, . . .	214 00		214 00	
H. W. Johns Manufacturing Co., asbestos covering, . . .	194 20		194 20	
New England Structural Co., steel work for valve chambers, . .	1,496 00		1,496 00	
C. H. Eglee Co., gate house and connections at Spot Pond, . .	7,203 05		21,559 74	
T. W. Kinser & Sons, high-service reservoir, Middlesex Fells, .	29,972 29		29,972 29	
Sundry bills under this contract,	5,066 19		5,066 19	
Nawn & Brock, completing high-service reservoir, . . .	2,830 40		2,830 40	
Amounts carried forward, . .	$442,831 44	$615,253 77	$2,262,686 29	$4,511,190 31

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending Dec. 31, 1898.		From Beginning of Work and ending Dec. 31, 1898.	
Amounts brought forward,	$442,831 44	$615,253 77	$2,262,686 29	$4,511,190 31
Construction — Con.				
Contracts, distribution system — *Con.*				
Norcross Bros., Chestnut Hill low-service pumping station,	16,691 22		16,691 22	
The Atlantic Works, sluice gates,	591 60		591 60	
	$460,114 26		$2,279,969 11	
Deduct value of pipes, valves, etc., included in above list, since transferred to maintenance account, and shown on page 53,	2,628 13	457,486 13	2,628 13	2,277,340 98
Additional work: —				
Labor,	$87,428 34		$159,081 93	
Medical services, analyses, etc.,	159 50		495 10	
Travelling,	334 60		556 52	
Rent,	519 73		2,173 37	
Water rates,	32 49		67 49	
Freight and express,	623 97		1,833 52	
Jobbing and repairing,	1,717 59		2,721 87	
Tools, machinery, appliances, and hardware supplies,	9,381 82		19,733 95	
Castings, ironwork and metals,	6,991 14		14,119 88	
Iron pipe and valves,	7,379 82		14,899 03	
Blasting supplies,	166 52		482 24	
Paint and coating,	374 73		2,511 61	
Fuel, oil and waste,	1,160 57		1,861 92	
Lumber and field buildings,	9,866 05		23,690 59	
Drain pipe,	1,198 34		1,826 17	
Brick, cement and stone,	3,437 09		4,514 40	
Sand, gravel and filling,	611 78		2,327 67	
Municipal and corporation work,	16,327 08		52,037 00	
Police service,	13,104 91		73,462 92	
Sanitary inspection,	434 79		3,878 61	
Judgments,	-		1,000 00	
Unclassified supplies,	1,529 25		2,432 72	
Miscellaneous expenses,	1,961 63		2,510 16	
Reimbursement city of Boston,	-	164,741 74	21,765 87	409,984 54
Legal and expert: —				
Legal services,	-		$3,368 82	
Expert services,	$250 00		475 87	
Court expenses,	-		57 86	
Miscellaneous expenses,	18 00	268 00	33 35	3,935 90
Amounts carried forward,	. . .	$1,237,749 64		$7,202,451 73

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending Dec. 31, 1898.		From Beginning of Work, and ending Dec 31, 1898.	
Amounts brought forward,		$1,237,749 64		$7,202,451 73
Real Estate.				
Legal and expert: —				
Legal services,	$280 00		$4,736 31	
Conveyancer and assistants,	13,962 38		47,414 18	
Experts,	40 00		13,829 40	
Appraisers,	1,939 40		5,267 19	
Court Expenses,	14 70		34 72	
Counsel expenses,	-		43 25	
Conveyancing supplies,	424 88		2,334 19	
Conveyancing expenses,	1,326 50		2,466 06	
Miscellaneous expenses,	303 71		382 91	
Reimbursement, city of Boston,	-		11,866 50	
Settlements by Board,	523,871 19		2,087,225 94	
Settlements, reimbursement, city of Boston,	-		531,606 00	
Judgments,	633 60		633 60	
Taxes and tax equivalents,	24,581 13		29,891 87	
Care and disposal,	3,706 62	571,084 11	4,801 97	2,742,534 09
Damages to Real Estate not taken, to Business, and on Account of Loss of Wages.				
Legal and expert services,	-		$1,130 67	
Settlements,	$26,349 68	26,349 68	27,049 68	28,180 35
Claims on Account of Diversion of Water.				
Legal and expert: —				
Legal services,	-		$3,749 98	
Expert services,	$3,191 72		10,459 42	
Miscellaneous expenses,	200 97		200 97	
Settlements,	34,500 00	37,892 69	849,350 00	863,760 37
Purchase of Existing Water Works.				
Legal and expert: —				
Legal services,	-		$1,835 84	
Miscellaneous expenses,	$409 86		469 16	
Settlements,	5,025,000 00	5,025,409 86	5,025,000 00	5,027,305 00
Amounts carried forward,		$6,898,485 98		$15,864,231 54

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending Dec. 31, 1898.		From Beginning of Work, and ending Dec. 31, 1898.	
Amounts brought forward, . .	. . .	$6,898,485 98		$15,864,231 5
Maintenance and Operation.				
Administration: —				
Commissioners, ...	$2,400 00		$2,400 00	
Secretary, auditor and assistants, .	3,860 00		3,860 00	
Postage, printing, stationery and other supplies, ...	233 98		233 98	
Telephone, heating, lighting and care of building, ...	259 78		259 78	
Miscellaneous expenses, . .	1 30		1 30	
Supervision and general superintendence: —				
Chief engineer and department engineers, ...	5,666 67		5,666 67	
Engineering and clerical assistants,	5,277 78		5,277 78	
Postage, printing, stationery and office supplies, ...	404 87		404 87	
Telephone, heating, lighting and care of offices, ...	655 33		655 33	
Travelling and incidental expenses,	499 67		499 67	
Miscellaneous expenses, . .	195 05		195 05	
Alterations and repairs of buildings,	873 02		873 02	
Pumping service: —				
Labor, ...	24,451 77		24,451 77	
Fuel, ...	17,542 20		17,542 20	
Oil, waste and packing, . . .	748 28		748 28	
Repairs and renewals, . . .	1,974 04		1,974 04	
Small supplies and expenses, .	1,714 16		1,714 16	
Pumping by municipalities, . .	2,553 69		2,553 69	
Superintendent and assistant superintendents, ...	3,249 60		3,249 60	
Engineering assistants, . . .	4,247 01		4,247 01	
Laboratory force, ...	2,639 92		2,639 92	
Sanitary inspectors, ...	2,367 72		2,367 72	
Recording and scientific instruments and supplies, ...	832 44		832 44	
Labor and teaming, ...	53,219 49		53,219 49	
Tools, machinery and appliances, .	2,449 62		2,449 62	
Lumber and hardware supplies, .	1,327 60		1,327 60	
Jobbing and repairing, . . .	1,680 40		1,680 40	
Travelling, ...	1,063 23		1,063 23	
Horses, vehicles and stable expenses,	3,574 18		3,574 18	
Fuel, ...	1,543 12		1,543 12	
Alterations and repairs of buildings,	402 97		402 97	
Municipal and corporation work, .	200 00		200 00	
Amounts carried forward, . .	$148,108 89	$6,898,485 98	$148,108 89	$15,864,231 5

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending Dec. 31, 1898.		From Beginning of Work, and ending Dec. 31, 1898.	
Amounts brought forward, . .	$148,108 89	$6,898,485 98	$148,108 89	$15,864,231 54
Maintenance and Operation — Con.				
Taxes, ...	3,563 98		3,563 98	
Contracts for pipes, valves, etc., originally charged to construction, since transferred to maintenance (included in list, pages 48, 49 and 50), ...	2,628 13		2,628 13	
Unclassified supplies, . . .	2,591 88		2,591 88	
Miscellaneous expenses, . . .	1,294 43		1,294 43	
Total, ...		158,187 31		158,187 31
Total expenditures, . . .	. . .	$7,056,673 29		$16,022,418 85

The following division will show *costs of the different works.*

EXPENDITURES FOR DIFFERENT WORKS.	For the Year ending Dec. 31, 1898.		From Beginning of Work, and ending Dec. 31, 1898.	
General administration, applicable to all parts of the work, . .	. . .	$25,085 62		$98,125 49
Wachusett Dam and Reservoir.				
Wachusett dam: —				
Engineering, ...	$9,399 23		$36,541 65	
Preliminary work, ...	302 72		23,841 74	
Additional work, ...	583 59		583 59	
Contracts, temporary works, . .	26 63		7,367 37	
Additional work, temporary works,	14,596 81		73,086 46	
North dike, engineering, . . .	16,753 89		31,680 81	
preliminary work, . .	3,165 78		27,578 86	
contracts, . . .	24,999 60		25,011 97	
additional work, . .	15,900 85		15,900 85	
South dike, engineering, . . .	247 00		1,141 95	
preliminary work, . .	49 42		2,485 98	
additional work, . .	36 00		36 00	
Removal of soil, engineering, . .	10,904 32		30,728 06	
preliminary work, .	16,507 46		27,732 57	
contracts, . .	26,918 23		38,329 95	
additional work, .	2,397 09		2,575 09	
Relocation of railroads: —				
Engineering, ...	1,776 41		4,573 77	
Preliminary and additional work,	116 87		116 87	
Amounts carried forward, . .	$144,681 90	$25,085 62	$349,313 54	$98,125 49

EXPENDITURES FOR DIFFERENT WORKS.	For the Year ending Dec. 31, 1898.		From Beginning of Work, and ending Dec. 31, 1898.	
Amounts brought forward,	$144,681 90	$25,085 62	$349,313 54	$98,125 49
Wachusett Dam and Reservoir — Con.				
Roads and bridges, engineering,	12,880 83		21,030 21	
preliminary work,	199 08		499 51	
contracts, roads,	27,851 50		34,979 86	
additional work,	7,912 57		8,447 32	
Real estate: —				
Engineering,	7,007 85		38,017 80	
Legal, conveyancing and expert,	12,668 74		54,036 28	
Mill property and water rights,	100,000 00		1,111,000 00	
Other property for reservoir and margins: —				
Clinton,	35,505 47		116,741 47	
Boylston,	33,415 00		124,480 00	
West Boylston,	257,375 00		518,420 00	
Sterling,	1,250 00		21,345 75	
Outlying property: —				
Clinton,	1,950 00		5,559 00	
Boylston,	–		370 00	
West Boylston,	–		2,030 00	
Lancaster,	5,788 00		5,788 00	
Taxes and tax equivalents,	23,024 28		23,105 17	
Care and disposal,	3,509 52		4,082 12	
Damages in West Boylston: —				
Real estate, not taken,	375 00		375 00	
Decrease of business,	19,425 00		19,725 00	
Loss of wages,	6,549 68		6,949 68	
Legal and expert (except in real estate),	–	701,369 42	1,130 67	2,467,426 38
Improving Wachusett Watershed.				
Engineering,	$1,174 26		$1,174 26	
Preliminary work,	40 00	1,214 26	40 00	1,214 26
Wachusett Aqueduct.				
Engineering,	$18,538 29		$158,441 17	
Preliminary work,	–		3,545 79	
Contracts, tunnel,	49,912 73		342,005 80	
covered masonry,	34,413 94		854,966 21	
Assabet bridge,	66 70		66,239 46	
terminal chamber,	663 00		8,641 60	
open channel,	36,560 81		143,642 77	
Amounts carried forward,	$140,155 47	$727,669 30	$1,577,482 80	$2,566,766 13

EXPENDITURES FOR DIFFERENT WORKS.	For the Year ending Dec. 31, 1898.		From Beginning of Work, and ending Dec. 31, 1898.	
Amounts brought forward,	$140,155 47	$727,669 30	$1,577,482 80	$2,566,766 13
Wachusett Aqueduct — Con.				
Additional work,	32,695 62		76,703 22	
Legal, conveyancing and expert,	886 95		10,280 29	
Real estate: —				
Property and easements: —				
Berlin,	2,000 00		10,357 50	
Clinton,	-		17,700 00	
Northborough,	13,723 90		17,281 40	
Marlborough,	350 00		1,957 50	
Southborough,	315 00		1,015 00	
Taxes, care and disposal,	121 65	190,248 59	626 99	1,713,404 70
Sudbury Dam and Reservoir.				
Dam, engineering,	$3,289 71		$45,236 84	
preliminary work,	3 40		4,766 88	
contracts, core wall,	-		88,773 86	
embankments,	-		127,574 66	
masonry section,	-		327,027 27	
superstructure,	275 00		18,062 92	
sluice gates and iron work,	-		4,918 06	
spillway channel,	988 08		988 08	
additional work,	6,418 08		27,837 88	
Reservoir, engineering,	13,030 68		124,092 15	
preliminary work,	-		51,413 54	
contracts, removal of soil and deepening,	117,110 74		1,119,916 59	
roads and railroads,	1,000 00		216,645 37	
regulating dam,	-		4,550 27	
additional work,	10,352 23		59,537 14	
Legal, conveyancing and expert,	2,402 37		18,042 43	
Real estate, property,	57,473 60		591,848 28	
taxes, care and disposal,	1,632 30	213,976 19	6,879 56	2,838,111 78
Protection of Sudbury Supply.				
Engineering,	$4,116 14		$6,418 26	
Preliminary work,	1,215 60		1,305 83	
Contracts,	2,380 45		14,283 99	
Additional work,	-		91 27	
Real estate,	-		37,626 32	
Legal, conveyancing and expert,	71 30	7,783 49	83 30	59,808 97
Amounts carried forward,	. . .	$1,139,677 57		$7,178,091 58

EXPENDITURES FOR DIFFERENT WORKS.	For the Year ending Dec. 31, 1898.		From Beginning of Work, and ending Dec. 31, 1898.	
Amounts brought forward,		$1,139,677 57		$7,178,091 58
Improving Sudbury Watershed.				
Engineering,	$5,666 34		$6,494 69	
Additional work,	9,577 64		9,577 64	
Real estate,	1,864 50		1,864 50	
Legal, conveyancing and expert,	209 60	17,318 08	209 60	18,146 43
Pipe Lines and Connections between Framingham Dams No. 3 and No. 1.				
Engineering,	$298 50		$2,528 19	
Preliminary work,	-		239 58	
Contracts,	31,678 44		44,415 28	
Additional work,	845 69	32,822 63	1,282 42	48,465 47
Pipe Line across Rosemary Valley.				
Engineering,	$1,939 68		$1,939 68	
Preliminary work,	24 62		24 62	
Contracts,	20,421 81		20,421 81	
Additional work,	647 94	23,034 05	647 94	23,034 05
Distribution System.				
Low service: —				
Pipe lines and connections: —				
Engineering,	$11,379 83		$86,339 36	
Preliminary work,	64 75		8,425 34	
Contracts, . . . Sect. 1,	4,393 88		23,990 48	
Sect. 2,	3 77		179,386 91	
Sect. 3,	5,043 52		32,678 13	
Sect. 4,	1,895 71		202,087 98	
Sect. 5,	9,220 70		48,866 79	
Sect. 6,	7,881 20		136,819 33	
Sect. 7,	10,885 21		131,592 98	
Sect. 8,	385 39		139,674 10	
Sect. 9,	30,382 26		108,627 80	
Sect. 10,	5,619 63		20,345 99	
Sect. 11,	7,063 72		141,495 15	
Sect. 12,	9,574 89		12,862 18	
Additional work,	8,575 64		37,185 17	
Additional work, . Sect. 1,	71 22		1,580 39	
Sect. 2,	1,110 43		3,154 18	
Sect. 3,	31 77		39 55	
Amounts carried forward,	$113,583 52	$1,212,852 33	$1,315,151 81	$7,267,737 53

EXPENDITURES FOR DIFFERENT WORKS.	For the Year ending Dec. 31, 1898.		From Beginning of Work, and ending Dec. 31, 1898.	
Amounts brought forward,	$113,583 52	$1,212,852 33	$1,315,151 81	$7,267,737 53
Distribution System — Con.				
Low service — *Con.*				
Pipe lines and connections — *Con.*				
Additional work, Sect. 4,	6,702 28		10,935 35	
Sect. 5,	-		13 70	
Sect. 6,	721 70		1,871 93	
Sect. 7,	1,374 79		4,417 11	
Sect. 8,	2,221 56		4,142 62	
Sect. 9,	308 87		2,386 76	
Sect. 10,	3 91		10 69	
Sect. 11,	200 52		3,763 51	
Sect. 12,	750 00		750 00	
Pumping station: —				
Engineering,	14,203 70		20,048 84	
Preliminary work,	83 02		146 10	
Contracts, building,	17,230 74		17,230 74	
sluice gates,	591 60		591 60	
Additional work,	3,995 27		4,015 27	
Reservoir, engineering,	5,219 13		14,906 13	
preliminary work,	-		1,197 84	
contracts, gate chamber,	6,800 53		18,805 02	
additional work,	2,625 32		5,211 40	
Real estate,	2,500 00		5,886 50	
Legal, conveyancing and expert,	245 72	179,362 18	2,255 72	1,433,738 64
Northern high service: —				
Pipe lines and connections: —				
Engineering,	$9,791 84		$31,503 31	
Preliminary work,	92 45		1,575 91	
Contracts, Sect. 13,	667 84		74,500 86	
Sect. 14,	-		39,682 97	
Sect. 15,	29 21		41,373 97	
Sect. 16,	3,081 17		23,804 08	
Sect. 17,	31 77		6,930 47	
Sect. 18,	3,199 41		52,493 96	
Sect. 26,	31,900 75		31,900 75	
Sect. 27,	24,143 65		24,143 65	
Additional work,	2,871 21		5,652 43	
Additional work, Sect. 13,	19 23		162 57	
Sect. 14,	226 98		2,791 98	
Sect. 15,	58 05		468 48	
Sect. 16,	173 81		311 30	
Amounts carried forward,	$76,287 37	$1,392,214 51	$337,296 69	$8,701,476 17

EXPENDITURES FOR DIFFERENT WORKS.	For the Year ending Dec. 31, 1898.		From Beginning of Work, and ending Dec. 31, 1898.	
Amounts brought forward, . .	$76,287 37	$1,392,214 51	$337,296 69	$8,701,476 1
Distribution System — Con.				
Northern high service — *Con.*				
Pipe lines and connections — *Con.*				
Additional work, . Sect. 17,	106 40		106 40	
Sect. 18,	400 91		1,029 83	
Sect. 26,	64 89		64 89	
Sect. 27,	45 63		45 63	
Pumping station: —				
Engineering, ...	2,673 76		4,033 78	
Preliminary work, . . .	20 00		37 00	
Contracts, ...	33 48		33 48	
Additional work, . . .	837 06		861 06	
Reservoir, engineering, . . .	8,479 40		12,362 25	
preliminary work, .	83 88		889 65	
contracts, . . .	38,540 07		38,540 07	
additional work, . .	1,525 69		1,644 65	
Real estate, ...	-		13,200 00	
Legal, conveyancing and expert, .	211 90	129,310 44	452 55	410,597 93
Southern high service: —				
Pipe lines and connections: —				
Engineering, ...	$16,865 62		$34,197 50	
Preliminary work, . . .	76 03		1,928 26	
Contracts, . . . Sect. 19,	82,493 65		171,882 10	
Sect. 20,	105,526 90		105,526 90	
Sect. 21,	4,617 56		48,194 57	
Sect. 23,	5,879 81		42,594 76	
Sect. 24,	12,835 44		37,602 84	
Sect. 25,	9,255 15		9,255 15	
Additional work, . . .	11,620 75		20,012 71	
Additional work, . Sect. 19,	2,236 47		4,737 23	
Sect. 20,	742 52		742 52	
Sect. 21,	1,264 84		1,406 75	
Sect. 23,	809 52		809 52	
Sect. 24,	3,119 57		3,131 92	
Sect. 25,	339 96		339 96	
Pumping station: —				
Engineering, ...	5,299 84		11,883 49	
Preliminary work, . . .	7 88		96 93	
Contracts, building, . . .	35,881 42		49,124 92	
engines, . . .	52,700 00		52,700 00	
boilers, . . .	13,650 00		13,650 00	
Additional, ...	7,675 82		7,716 92	
Amounts carried forward, . .	$372,898 75	$1,521,524 95	$617,534 95	$9,112,074 10

EXPENDITURES FOR DIFFERENT WORKS.	For the Year ending Dec. 31, 1898.		From Beginning of Work, and ending Dec. 31, 1898.	
Amounts brought forward, . .	$372,898 75	$1,521,524 95	$617,534 95	$9,112,074 10
Distribution System — Con.				
Southern high service — *Con.*				
Reservoir, engineering, . . .	454 09		1,307 31	
preliminary work, .	4 75		91 85	
additional work, . .	95 00		95 00	
Real estate, ...	425 00		4,425 00	
Legal, conveyancing and expert, .	47 50	373,925 09	2,208 84	625,662 95
Northern Extra High Service.				
Engineering, ...	. . .	-		463 77
Glenwood Pipe Yard.				
Real estate, ...	. . .	6,389 32		6,389 32
Diversion of Water, South Branch of Nashua River.				
Engineering, ...	$1,638 65		$12,976 10	
Legal, conveyancing and expert, .	3,701 11		16,590 05	
Settlements, ...	34,500 00		849,350 00	
Clinton sewerage system: —				
Engineering, ...	11,702 47		12,261 59	
Preliminary work, ...	1,761 97		1,770 97	
Contracts, ...	32,366 92		32,366 92	
Additional work, ...	1,328 71		1,328 71	
Real estate, ...	4,180 00	91,179 83	4,180 00	930,824 34
Examination of Existing Water Works, and Payments on Account of same.				
Engineering, ...	$8,128 22		$11,825 80	
Legal, conveyancing and expert, .	1,916 93		4,866 92	
Settlements, ...	5,025,000 00	5,035,045 15	5,025,000 00	5,041,692 72
		$7,028,064 34		
Pipes, Valves, Castings, etc., sent first to Storage Yards, and afterwards transferred as needed to Different Parts of the Work.				
Sent to storage yards, . . .	$153,769 26		$1,501,261 76	
Transferred from storage yards to works, and included in costs above,	283,347 62*		1,354,137 42	
Balance from beginning of work, .	. . .			147,124 34
Excess of transfers over purchases during the year 1898, . . .	. . .	129,578 36*		
Amounts carried forward, . .	. . .	$6,898,485 98		$15,864,231 54

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* In order to show the full cost of each part of the work, there has been included the value of pipes, valves, etc., originally charged to stock and since transferred to the works. As the amount thus transferred during the year 1898 exceeded by $129,578.36 the amount received for the same period, being material on hand from former years, this excess is deducted from the aggregate of costs, the result being the amount expended during the year for construction and acquirement.

EXPENDITURES FOR DIFFERENT WORKS.	For the Year ending Dec. 31, 1898.		From Beginning of Work, and ending Dec. 31, 1898.	
Amounts brought forward, . .	. . . .	$6,898,485 98		$15,864,231 54
Maintenance and Operation.				
Administration, ...	-	6,755 06		6,755 06
General supervision: —				
Services, ...	$1,475 00		$1,475 00	
Supplies and expenses, . . .	185 27	1,660 27	185 27	1,660 27
Taxes, ...	-	3,563 98		3,563 98
Dam and aqueduct department: —				
General superintendence: —				
Services, ...	$1,072 48		1,072 48	
Supplies and expenses, . .	301 00		301 00	
Dam and aqueduct: —				
Labor, ...	3,656 97		3,656 97	
Supplies and expenses, . .	749 14		749 14	
Sanitary inspection: —				
Labor, ...	233 77		233 77	
Supplies and expenses, . .	33 02	6,046 38	33 02	6,046 38
Sudbury department: —				
General superintendence: —				
Services, ...	$6,678 86		$6,678 86	
Supplies and expenses, . .	1,536 57		1,536 57	
Superintendence, Framingham office: —				
Labor, ...	3,911 69		3,911 69	
Supplies and expenses, . .	766 88		766 88	
Sudbury Reservoir: —				
Labor, ...	2,817 44		2,817 44	
Supplies and expenses, . .	587 66		587 66	
Ashland Reservoir: —				
Labor, ...	1,064 21		1,064 21	
Supplies and expenses, . .	205 55		205 55	
Hopkinton Reservoir: —				
Labor, ...	2,132 43		2,132 43	
Supplies and expenses, . .	602 40		602 40	
Whitehall Reservoir: —				
Labor, ...	238 00		238 00	
Supplies and expenses, . .	137 31		137 31	
Framingham Reservoirs, 1, 2 and 3: —				
Labor, ...	3,059 91		3,059 91	
Supplies and expenses, . .	1,080 78		1,080 78	
Amounts carried forward, . .	$24,819 69	$6,916,511 67	$24,819 69	$15,882,257 23

EXPENDITURES FOR DIFFERENT WORKS.	For the Year ending Dec. 31, 1898.		From Beginning of Work, and ending Dec. 31, 1898.	
Amounts brought forward, . .	$24,819 69	$6,916,511 67	$24,819 69	$15,882,257 23
Maintenance and Operation — Con.				
Sudbury department — *Con.*				
Lake Cochituate: —				
Labor, ...	2,027 32		2,027 32	
Supplies and expenses, . .	394 16		394 16	
Pegan filters: —				
Labor, ...	1,959 97		1,959 97	
Supplies and expenses, . .	832 28		832 28	
Sudbury and Cochituate watersheds: —				
Labor, ...	414 00		414 00	
Supplies and expenses, . .	231 67		231 67	
Sanitary inspection: —				
Labor, ...	2,251 30		2,251 30	
Supplies and expenses, . .	181 55		181 55	
Sudbury and Cochituate Aqueducts: —				
Labor, ...	8,733 41		8,733 41	
Supplies and expenses, . .	3,278 54		3,278 54	
Chestnut Hill Reservoir: —				
Labor, ...	7,355 48		7,355 48	
Supplies and expenses, . .	866 85		866 85	
Biological laboratory: —				
Labor, ...	2,700 31		2,700 31	
Supplies and expenses, . .	1,131 78	57,178 31	1,131 78	57,178 31
Distribution department: —				
General superintendence: —				
Services, ...	1,733 11		1,733 11	
Supplies and expenses, . .	590 10		590 10	
Pumping service, Chestnut Hill high-service pumping station:				
Labor, ...	22,705 91		22,705 91	
Fuel, ...	16,116 70		16,116 70	
Repairs, ...	2,062 11		2,062 11	
Oil, waste and packing, . .	718 83		718 83	
Small supplies, ...	830 21		830 21	
Melrose pumping station: —				
Labor, ...	1,457 08		1,457 08	
Fuel, ...	1,807 55		1,807 55	
Supplies and expenses, . .	422 74		422 74	
Amounts carried forward, . .	$48,444 34	$6,973,689 98	$48,444 34	$15,939,435 54

EXPENDITURES FOR DIFFERENT WORKS.	For the Year ending Dec. 31, 1898.		From Beginning of Work, an ending Dec. 31, 1898.	
Amounts brought forward, . .	$48,444 34	$6,973,689 98	$48,444 34	$15,939,435
Maintenance and Operation — Con.				
Distribution department — *Con.*				
Chelsea pumping station: —				
Labor, ...	767 00		767 00	
Fuel, ...	1,083 00		1,083 00	
Repairs and supplies, . . .	1,013 01		1,013 01	
Buildings at Chestnut Hill: —				
Labor, ...	1,235 24		1,235 24	
Supplies and expenses, . .	266 00		266 00	
Spot Pond: —				
Labor, ...	866 56		866 56	
Supplies and expenses, . .	368 32		368 32	
Mystic Lake, conduit and pumping station: —				
Labor, ...	2,702 29		2,702 29	
Supplies and expenses, . .	1,056 29		1,056 29	
Mystic Reservoir, College Hill: —				
Labor, ...	1,659 87		1,659 87	
Supplies and expenses, . .	1,300 55		1,300 55	
Low service, pipe lines: —				
Labor, ...	11,255 61		11,255 61	
Supplies and expenses, . .	5,712 36		5,712 36	
Northern high service, pipe lines: —				
Labor, ...	437 00		437 00	
Supplies and expenses, . .	2,982 65		2,982 65	
Southern high service, pipe lines: —				
Labor, ...	1,236 07		1,236 07	
Supplies and expenses, . .	597 15	82,983 31	597 15	82,983 3
Total for constructing, acquiring and maintaining works, . .	. . . .	$7,056,673 29		$16,022,418 8

(*b*) RECEIPTS. — The total amount of receipts from rents, sales of property, etc., for the year beginning January 1, 1898, and ending December 31, 1898, is $55,531.17; and the total amount from the time of the organization of the Board, July 19, 1895, to December 31, 1898, is $68,181.14. The general character of these receipts is as follows: —

	For the Year ending Dec. 31, 1898.	From Beginning of Work, and ending Dec. 31, 1898.
Forfeiture for contracts awarded, but not executed,	–	$500 00
Rents from real estate,	$8,846 36	16,855 99
Sales of real estate and buildings,	1,325 60	2,567 60
Land products,	2,967 13	4,282 33
Labor, tools and supplies,	2,308 91	3,807 27
Payments on account of admission into the Metropolitan Water District,	20,000 00	20,005 00
Payments on account of supplying water outside district,	20,000 00	20,000 00
Unclassified receipts,	83 17	162 95
Totals,	$55,531 17	$68,181 14

The foregoing receipts have been credited to the various objects or works as follows: —

	For the Year ending Dec. 31, 1898.	From Beginning of Work, and ending Dec. 31, 1898.
Admission into Metropolitan Water District (Nahant & Quincy),	$20,000 00	$20,005 00
Supplying water outside of water district (Swampscott),	20,000 00	20,000 00
Construction: —		
Wachusett Reservoir,	10,291 23	16,317 57
Wachusett Aqueduct,	84 00	246 42
Sudbury Reservoir,	1,662 20	6,265 00
Distribution system,	1,836 95	3,690 36
Diversion of water (Clinton sewerage system),	69 50	69 50
Maintenance: —		
Wachusett Aqueduct,	234 00	234 00
Sudbury system,	1,260 12	1,260 12
Distribution system,	93 17	93 17
Totals,	$55,531 17	$68,181 14

(*c*) Assets. — The value of the assets is given, as far as practicable, at cost prices: —

Desks, chairs, safes, drafting tables, plan cases, typewriting machines, electrical fittings and general office fixtures and supplies,	$19,220 00
Transits, levels, planimeters, scales and other engineering instruments; drafting paper and general drafting supplies; outfits for cement testing, blueprinting, photography, and chemical analyses; laboratory supplies, etc., ...	28,270 00
Atlases, maps, portfolios and reference books, ...	1,900 00
Railroad and electric road tickets, ...	1,620 00
Horses, vehicles, farm machinery and stable supplies, . . .	9,270 00
Portable cells, revolvers, handcuffs, belts and other police supplies,	1,700 00
Engines, pumps, boilers, derricks, diamond and other drills, lumber, field buildings, tools and general construction supplies, . .	67,410 00
Pipes, valves, castings, etc., classed as stock, ...	143,840 00
	$273,230 00

In addition to the above, there are numerous pumps, engines, boilers, derricks and other appliances for construction work; wagons, rollers and other implements for use in the care of grounds and miscellaneous supplies and material for various purposes, included in the taking from the city of Boston on January 1, 1898, the value of which has not yet been determined; numerous note and calculation books, studies, plans, etc., of great value to the Board, to which no stated value can be assigned; real estate in the site of the proposed Wachusett Reservoir; a lot and building in Clinton, used as the office and headquarters of the Board in that place; also the completed works, and works in process of construction, in the care of the Board.

(*d*) Liabilities. — There are liabilities as follows: —

Unpaid bill of Seth Twitchell, ...	$375 00*
Due on monthly pay rolls, ...	6,600 00†

---

* Sundry other petty bills due January 1, 1899, have since been paid.

† Since paid.

Reserved on Approved Monthly Estimates for Work done (not due until Completion of Contracts).

Name.	Work.	Amount.
Mignault & McGrain, . . .	Sudbury Dam, . . .	$174 37
Washburn & Washburn, . .	Sudbury Reservoir, . .	21,154 87
Washburn & Washburn, . .	Sudbury Reservoir, . .	18,734 79
T. H. Riddle & Co., . . .	Wachusett Reservoir, . .	6,832 78
J. D. Gennaro, ...	Wachusett Reservoir, . .	2,867 44
Silvio Casparis, ...	Wachusett Aqueduct, . .	2,500 00
Silvio Casparis, ...	Wachusett Aqueduct, . .	3,300 00
Moulton & O'Mahoney, . . .	Wachusett Aqueduct, . .	12,407 55
O. Cunningham & Son, . . .	Clinton sewerage system, .	1,771 97
Newell & Snowling Construction Company, ...	Clinton sewerage system, .	2,755 27
C. A. Dodge & Co., . . .	Chestnut Hill pumping station,	1,881 19
H. A. Hanscom & Co., . . .	Pipe-laying, ...	4,551 23
McNeal Pipe and Foundry Company, ...	Special castings, . . .	576 30
Camden Iron Works, . . .	Special castings, . . .	198 00
Norcross Bros., ...	Low-service pumping station,	4,172 81
Atlantic Works, ...	Sluice gates, ...	104 40
Mirick & Wentworth, . . .	Pipe-laying, ...	1,593 31
O'Rourke & Nelson, . . .	Pipe-laying, ...	1,371 30
Nawn & Brock, ...	Reservoir, Middlesex Fells, .	499 48
Total, ...	. . . .	$87,447 06

In addition to the above, there are amounts which will be due for a few parcels of real estate in the Sudbury Reservoir, for takings on the line of the Wachusett Aqueduct, and for takings, for damage to business, loss of employment and depreciation in real estate not taken, on account of the Wachusett Reservoir.

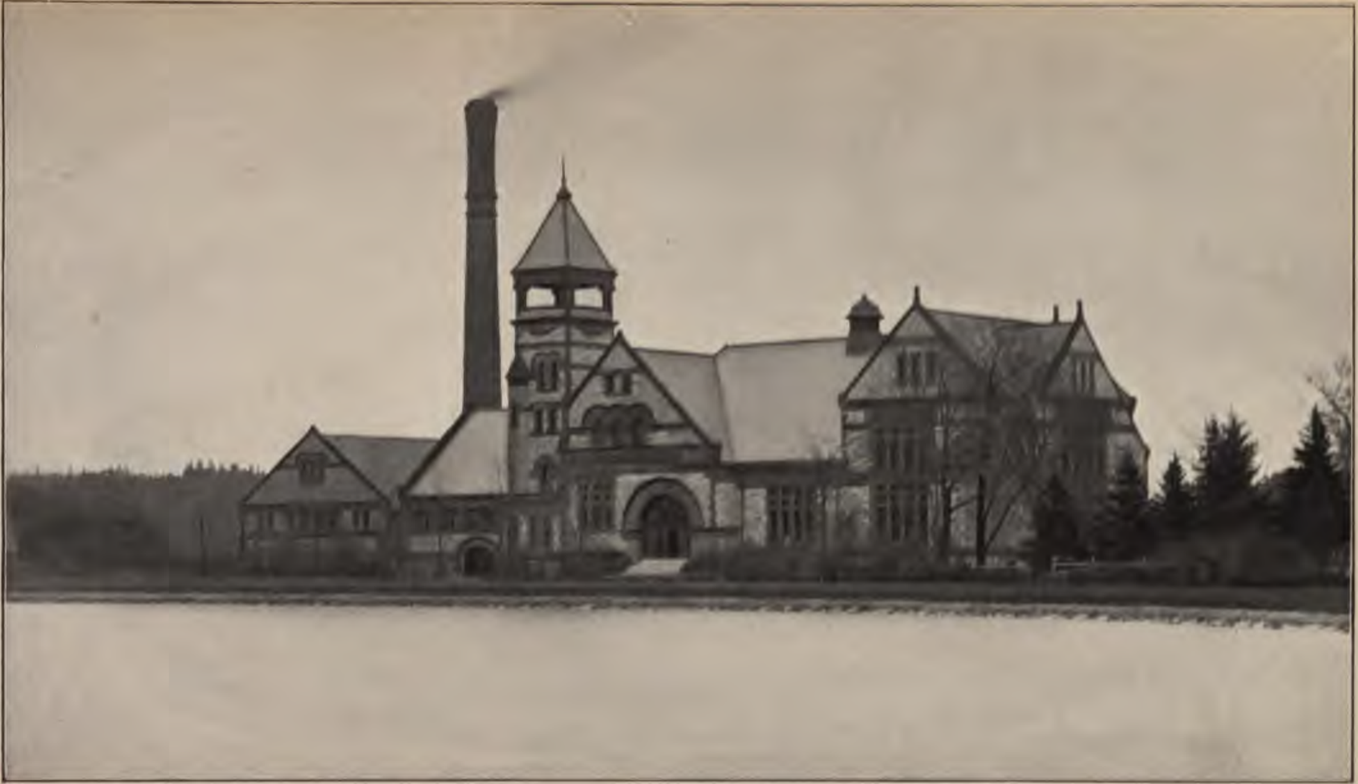
It is impossible to state the amounts due on the following claims for land damages mentioned above, the same not being liquidated, still subject to negotiations, and no formal statements of amounts claimed having been made: Ann Moran, heirs Owen Kerley, Margaret F. Tonnery, heirs Thomas Prendergast, heirs Patrick Cain, Bridget Cauley, heirs Thos. K. Cunningham *et als.*, Patrick T. Moran, Harriet Wilder, James H. Wood, Lawrence Downey, George Murrman, Frank E. Chandler, Thomas H. O'Connor, Chas. A. Rand, trustee, heirs E. Warren Pierce, Joseph H. Derosier, Fred W. Richardson, Mary L. Ballou, trustee, John L. Byard, David O'Connell, Thomas Connors, Joseph Lalone, Martha A. Andrews, Charles E. Smith, G. C. Hudson, S. M. Church, R. P.

Boynton, John N. Whittemore, E. A. Currier, Richard Bourne, Mary Williams Swinscoe, Maria A. Haskell, Harriet Griffin, Victor Moisan, Catherine McLean, Alexander E. McLean, George Wilder, Ezra W. Chapin, Arthur E. Wood, *et als.*, Timothy John Fahy, Chloe Ann Ballou, William H. Buck, Joseph Leonard, John J. Clark, Frank A. Baker, George E. Walker, Harrison Neal, Henrietta M. Johnson, Charles F. Choate, Charles L. Johnson, Israel G. Howe, Josephine Burnett *et als.*, trustees, Charles B. Sawin, Eliza Barnes, Martha A. S. Forbes, Eben S. and W. A. Fuller, W. O. Johnson, Joseph B. Moore, heirs Owen Kittredge, Bridget Kittredge, Ida J. Reid *et als.*, Felix Nugent, Joseph F. McDonald, Timothy J. and Mary A. Lynch, John F. Philbin, Clarence Carvill, heirs Lorenzo F. Wood, James H. Moulton, Martin F. O'Malley, Ashley Wood *et als.*, Levi L. Flagg, Fred E. Russell, New York, New Haven & Hartford Railroad, Hattie E. Sawyer, Jeremiah Potter, J. R. Stott, Horace H. Lowe, Helen Spencer, Christian Schmidt, Sarah A. Laythe, G. A. Heighway, city of Boston, balance, city of Malden, balance, city of Medford, town of Melrose.

VI. Work accomplished and for the Future.

The first task imposed upon the Metropolitan Water Board by the Act of the year 1895 was to make available the water of the South Branch of the Nashua River, in order to relieve the danger of a scarcity of the water supply for the various cities and towns in the Metropolitan Water District. This work has been accomplished during the past year.

During the year, through its various departments, the Board has made the formal taking of the waters of the South Branch of the Nashua River; it has continued the work preliminary to the construction of the Wachusett Dam at Clinton, and has begun the construction of the Wachusett Reservoir; it has completed the Wachusett Aqueduct and the new basin in Southborough, now called the Sudbury Reservoir; it has taken from the city of Boston the Chestnut Hill Reservoir and pumping station, and all the rest of the works held by that city for the purposes of a water supply westward of the Chestnut Hill Reservoir, including Lake Cochituate, the Sudbury basins, the Sudbury and Cochituate aqueducts and the Mystic Lake and water works; and it has also taken Spot Pond and the surrounding lands, with their pumping stations, from the cities of



High-Service PUMPING STATION at Chestnut Hill Reservoir, with the recent ADDITION at the right.

Malden and Medford and the town of Melrose; it has pushed forward the works necessary for distributing the water among the different portions of the district by the extension of main pipe lines; and has made progress in the construction of new pumping stations, and additional storage facilities.

The waters flowing in the Nashua River have actually been diverted through the Wachusett Aqueduct into the Sudbury Reservoir, and made available as an additional water supply to the various parts of the Metropolitan Water District; and the Board has entered upon the operation of the works which have been taken and constructed, and assumed the duty of supplying water to all the cities and towns originally included in the Metropolitan Water District, and also to the city of Quincy.

The capacity of the water supply of the Metropolitan Water District, which can be depended upon, as is estimated, even in the driest year, has been increased from 69,000,000 gallons to upwards of 100,000,000 gallons per day; so that it is believed that the district has a sufficient supply of water of an improved quality until the completion of the further works which have been begun.

The coming season will be devoted to the prosecution of the work of building the Wachusett Reservoir, the erection of the new pumping stations at Chestnut Hill and at Spot Pond, the completion of the high-service distributing reservoir in Middlesex Fells, the improvement of Spot Pond, and the further connection by main pipe lines with the cities and towns in the district.

Respectfully submitted,

HENRY H. SPRAGUE.
WILMOT R. EVANS.
HENRY P. WALCOTT.

BOSTON, Jan. 1, 1899.

REPORT OF THE CHIEF ENGINEER.

To the Metropolitan Water Board.

GENTLEMEN : — The following is a report of the operations of the engineering department for the year ending December 31, 1898.

ORGANIZATION.

The maintenance of the works taken from the city of Boston and other municipalities and of works constructed under the Metropolitan Water Act was begun on January 1, 1898, and was placed by you under the direct charge of the engineering department.

This additional work did not require any large increase of the engineering force, although it added to the duties of those already employed; but it did require the organization of a large maintenance force, which consists largely of men previously employed by the city of Boston. The subdivision of the force into departments that had been adopted for the construction of the works was also followed in their maintenance.

The engineers reporting directly to the chief engineer are the same as at the date of the last report. The list is as follows : —

DEXTER BRACKETT, .	. *Engineer, Distribution Department.*
DESMOND FITZGERALD,	. *Engineer, Sudbury Department.*
THOMAS F. RICHARDSON,	. *Engineer, Dam and Aqueduct Department.*
HIRAM A. MILLER, .	. *Engineer, Reservoir Department.*
REUBEN SHIRREFFS, .	. *Principal Office Assistant.*
JOHN N. FERGUSON, .	. *Office Assistant.*

Joseph P. Davis and A. Fteley have continued to act as consulting engineers, and, in addition, Hiram F. Mills has acted as a consulting engineer in the preparation of plans for the construction of the North Dike.

F. H. Snow, who was engaged in 1897 to make investigations and a report upon the purification of the sewage of Clinton, made the final report upon this subject early in 1898.

H. B. Burley, who was engaged in 1897 to make examinations and a report upon a system for diverting into the Merrimac River a part of the sewage of the city of Nashua, N. H., also made a final report in 1898.

The amount of work constructed in 1898 was much smaller than in 1897. This has been due in part to the fact that a considerable portion of the time of the principal engineers has been occupied by the many questions connected with the maintenance of new works, and in part to the fact that the works already constructed had so far increased the capacity of the sources of supply and improved the quality of the water that it was more necessary to construct many of the smaller works and to finish works already undertaken than to undertake upon a large scale the construction of the great works connected with the Wachusett Reservoir and Dam.

As a consequence of this smaller amount of work constructed, it has been necessary to decrease the engineering force from time to time. At the beginning of the year, this force, including both those engaged upon construction and upon the maintenance of the works, numbered 165, and at the end of the year 141. In addition to the engineering force, which included the engineers engaged upon the inspection of the work, other inspectors have been employed to inspect pipe-making, pipe-laying, machinery, masonry and earth work. The maximum number so employed at one time during the year was 19.

Gangs of men, under the immediate direction of foremen and under the general direction of the engineers, have been employed upon the construction of the temporary works at the Wachusett Dam, to clear trees and brush from the land purchased for the Wachusett Reservoir, to make borings, to trim and seed embankments and grade the grounds along the Wachusett Aqueduct, to dig drainage ditches in swamps, to handle water pipes at the pipe yards and to do other minor work. There has also been a maintenance force, averaging 116, employed at the pumping stations and in connection with the maintenance of reservoirs, aqueducts, pipe lines and other works.

FORCE EMPLOYED ON WORKS.

The largest force employed upon the works at any one time during the year was in the latter part of October, as follows: —

	Men.		Horses.	
Contractors' force: —				
Reservoir department,	340		141	
Dam and Aqueduct department,	209		35	
Sudbury department,	83		9	
Distribution department,	632	1,264	77	262
Day-labor force, construction,		291		49
Engineering force, including engineer inspectors and those engaged upon maintenance,		150		–
Inspectors not engineers,		15		–
Maintenance force, not including civil engineers,		106		18
		1,826		329

In continuing this report, I will make a division into two parts, one relating to the construction and the other to the maintenance of the works.

CONSTRUCTION.

CONTRACTS.

A detailed statement of the contracts made and pending during the year is given in Appendix No. 1. The following statement gives a summary of all the formal contracts from the beginning of the work to the end of 1898: —

PORTION OF WORK.	Number of Contracts.	Approximate Amount.
Wachusett Reservoir,	7	$139,594 41
Wachusett Aqueduct and Clinton sewerage,	17	1,495,675 93
Sudbury Reservoir, contracts assumed from the city of Boston (uncompleted portions),	11	583,220 54
Sudbury Reservoir and pipe lines, contracts made by the Metropolitan Water Board,	19	853,007 84
Distribution department, including pipes purchased for other departments,	95	2,777,853 21
Totals,	149	$5,849,351 93

Number of contracts made and assumed in 1896,	56
Number of contracts made in 1897,	53
Number of contracts made in 1898,	40
	149

Amount of contracts made and assumed in 1896, including only the uncompleted portions of contracts assumed from the city of Boston (approximate),	$3,891,883 99
Amount of contracts made in 1897 (approximate),	1,232,456 92
Amount of contracts made in 1898 (approximate),	725,011 02
	$5,849,351 93

Number of contracts completed in 1896,	13
Number of contracts completed in 1897,	57
Number of contracts completed in 1898,	57
Number of contracts uncompleted December 31, 1898,	22
	149

Amount of contracts completed in 1896,	$651,449 77
Amount of contracts completed in 1897,	3,013,206 37
Amount of contracts completed in 1898,	1,435,228 08
	$5,099,884 22
Amount of contracts uncompleted December 31, 1898 (approximate),	1,261,467 71
	$6,361,351 93
Deduct for work done on 11 Sudbury Reservoir contracts by city of Boston,	512,000 00
	$5,849,351 93

Value of work done by contract to dates of December, 1896, estimates,	$2,029,022 12
Value of work done by contract from dates of December, 1896, estimates, to December 31, 1897,	2,679,951 79
Value of work done by contract from January 1, 1898, to December 31, 1898,	700,611 35
	$5,409,585 26
Value of work remaining to be done on uncompleted contracts December 31, 1898,	439,766 67
	$5,849,351 93

Of the 22 contracts remaining uncompleted at the end of 1898, the work was practically or wholly finished before the end of the year on 11 contracts, amounting to $723,106.21; but they are marked as uncompleted, because the final settlements had not been made.

All of the contracts completed up to the present time have been settled without any legal controversy. Out of the whole number of contracts, there has been only one instance in which the contractor has failed to complete the work.

RESERVOIR DEPARTMENT.

HIRAM A. MILLER, *Department Engineer.*

The work in this department has continued to be largely of a preliminary nature, but the construction of new highways and the removal of soil from the reservoir in connection therewith has been continued, and two small contracts and one larger contract for work on the North Dike have been made.

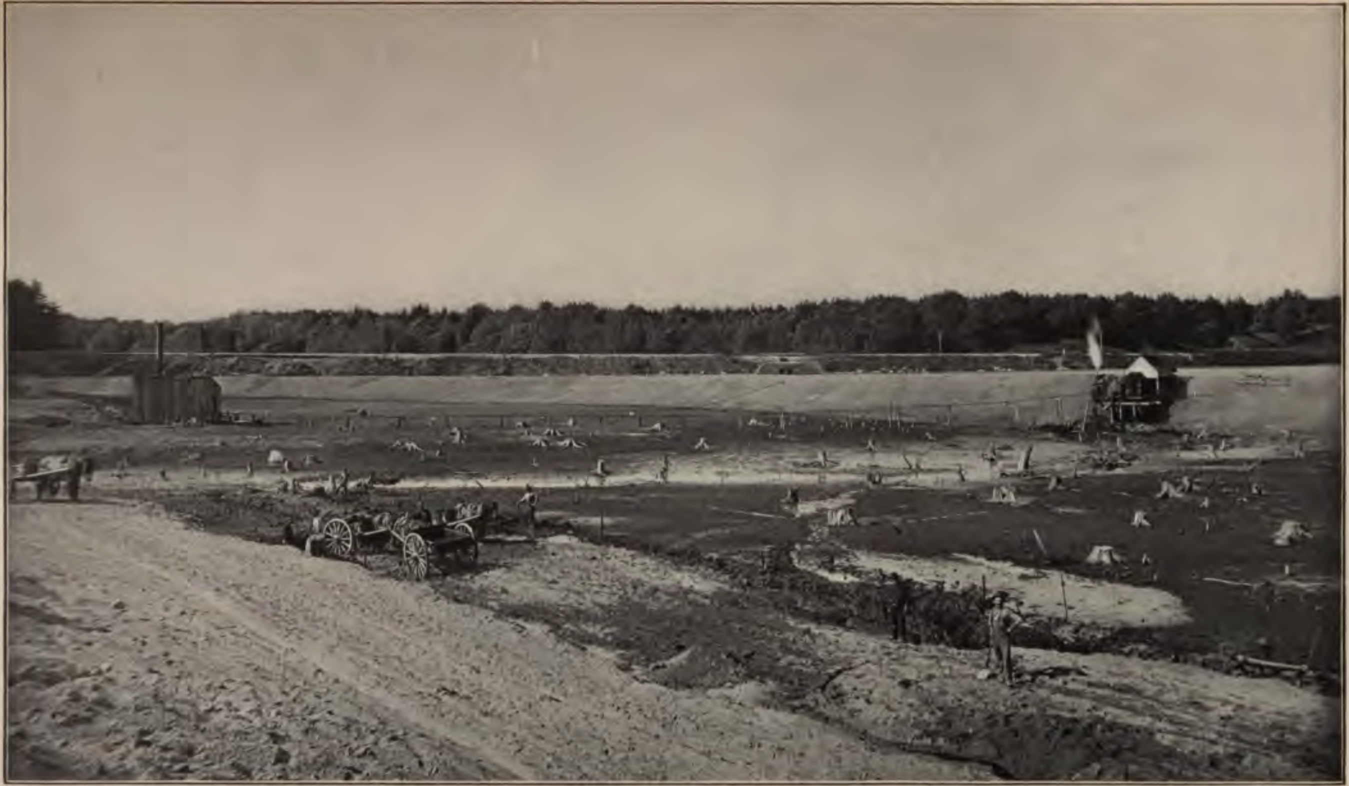
Some changes have been made in the organization of the engineering force, on account of the larger amount of construction in this department. The assistant engineers at the beginning of the year were Charles A. Bowman, Moses J. Look, Harry J. Morrison and Ernest H. Baldwin, and they have remained upon the force throughout the entire year. On March 8, Alexander E. Kastl, division engineer, who had previously been in charge of the construction of a division of the Wachusett Aqueduct, was transferred to the reservoir department and placed in direct charge at the North Dike. David Hinckley, assistant engineer, was transferred from the dam and aqueduct department to the reservoir department February 21.

The total engineering force in this department has varied from 19 to 40. In addition to these numbers, a portion of the drafting force of the dam and aqueduct department has been employed upon the work of the reservoir department, increasing the total force employed by an average of 2.

The main office of this department has been continued in the building erected by the board in Clinton. Two branch offices for construction parties have been established in the same town, one on Boylston Street and the other near the North Dike. The branch office at West Boylston has been continued throughout the year.

NORTH DIKE.

At the close of 1897 most of the preliminary investigations and experiments necessary for the location and design of the dike had been completed. During 1898, however, some additional experiments have been made upon the filtration of water through soils and sand, on the density of soils compressed in various ways and



DIKE THROUGH COACHLACE POND IN CLINTON.

THE
PUBLIC LIBRARY.

ASTOR, LENOX AND
TILDEN FOUNDATIONS.

on the stability of soils under a heavy load. Experiments were also made on driving sheet piling with the aid of a water jet. Observations of the elevation of the ground water around Sandy Pond and at other places in the vicinity of the North Dike have been made.

A topographical plan of the westerly portion of the dike, on a scale of 100 feet to an inch, has been completed, and a topographical plan of the whole of the territory in the vicinity of the North Dike, including a considerable area, north of the Boston & Maine Railroad, on a scale of 300 feet to an inch, has been made.

Sixty borings, 50 feet apart, with an aggregate depth of 1,388 feet, have been taken along the easterly portion of the dike, on a line from 200 to 400 feet north of the centre line, where it is proposed to excavate for a secondary cut-off. This makes the total number of borings at the site of the dike to date, 1,131, having an aggregate depth of 93,553 feet, equal to about 17¾ miles.

The designs for the dike have been completed and approved by the consulting engineers. Estimates of the quantities of excavation, embankment, slope paving and other work to be done in accordance with these final plans have been completed.

As one of the first steps for the construction of the easterly portion of the dike, it was desirable to lower the water in Sandy Pond. The method of drawing the water from the pond will be referred to subsequently. In connection with this lowering, however, in order to avoid lowering at the same time the water in Coachlace Pond, — which is a mill pond controlled by the Bigelow Carpet Company, — a small dike was built across the pond, 300 or 400 feet north of the toe of the northerly slope of the dike.

The contract for this small dike was made with Neill Devine & Co. March 25, work was commenced March 29 and the dike was completed May 9. The maximum force employed was 43 men and 22 horses. The total amount of earth work was 19,172 cubic yards. The dike is 1,212 feet long, and was constructed without drawing the water from the pond. The water in some places is more than 14 feet deep.

When the small dike was completed, as much of the water on its southerly side as possible was drawn off through Sandy Pond. Two pumping plants were installed (one on June 28 and the other on July 12), and run continuously, day and night, until August 3, when the portion of the pond south of the small dike was pumped dry. One pump was then stopped, and the other, a 6-inch centrifugal pump, was continued in service to keep the pond from filling up, and to permit work to be carried on in the bottom of the pond from the dike south to Sandy Pond.

The work to be done on the main dike is of such a nature that it is impracticable to maintain the roads at its site; and, as the work will continue for several years, a substantial and well-graded temporary road was constructed, to be used until a permanent marginal highway can be built. This temporary road crosses Coachlace Pond at the toe of the dike, and will be again referred to under the head of relocation and construction of roads.

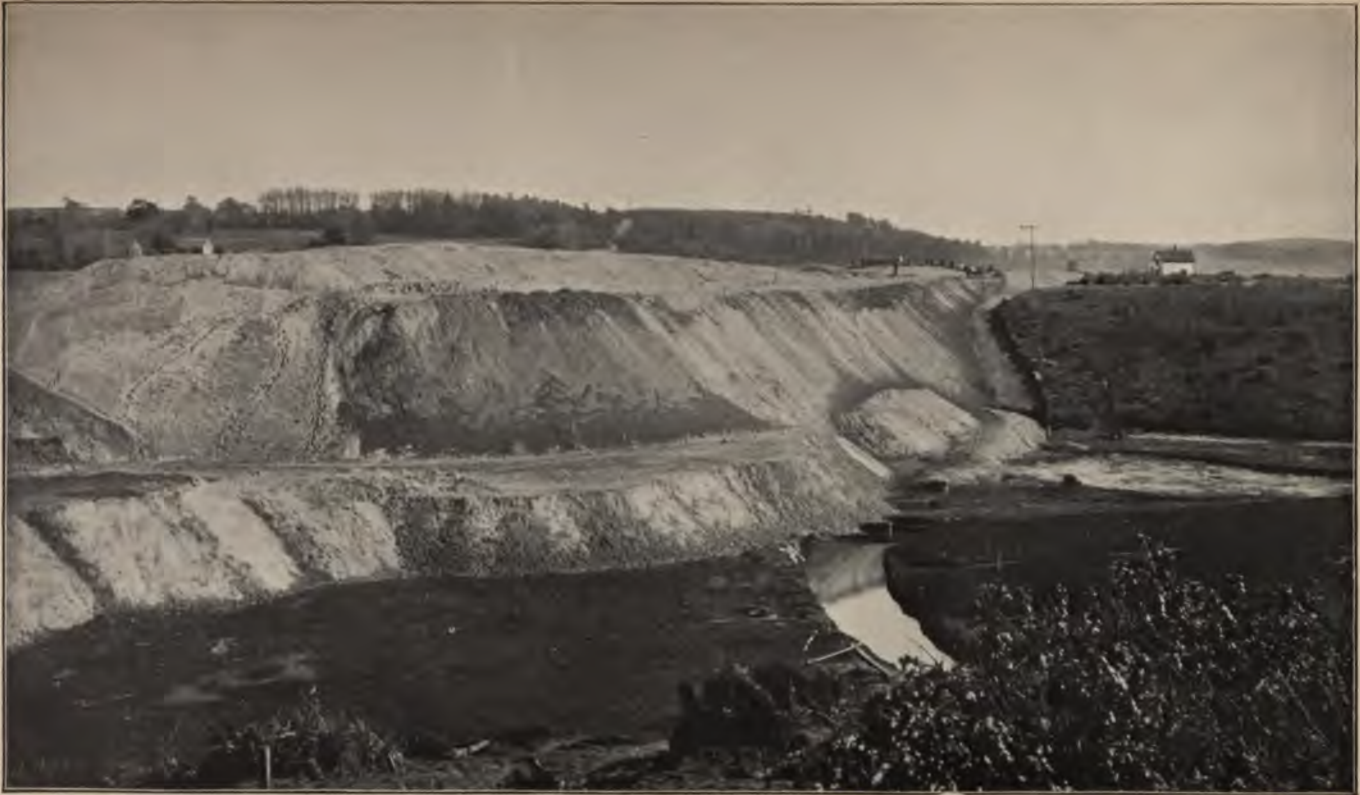
There were stumps, logs and a thin layer of muck or soil upon the bottom of Coachlace Pond, between the temporary road and the small dike. These were removed. Over a large portion of the area — which was approximately 5 acres — the material under the muck was a quicksand, and a considerable quantity of gravel was hauled in and spread over it, to prevent horses and carts from sinking into the quicksand while the work was in progress. About 9,000 cubic yards of muck were removed and about 6,000 cubic yards of gravel were spread over the quicksand.

On August 11 a contract was made with Joseph D. Gennaro for excavating about 290,000 cubic yards of earth at the easterly portion of the North Dike. The price paid is 14⅞ cents per cubic yard. This excavation is for the most part from a trench having a bottom width of 30 feet, side slopes of one horizontal to one vertical, and a depth for a large part of the length varying from 30 to 60 feet.

It is the purpose in making this trench to cut through the gravel and coarser grades of sand down to the nearly impervious sand found at greater depths, and then to fill the trench with compacted soil, which has been found by experiment to be almost absolutely water tight. The sand and gravel removed from the trench are utilized in the construction of portions of the dike.

Work was commenced under this contract August 17, and at the end of the year approximately 134,000 cubic yards of earth had been excavated. The maximum force employed was 152 men and 44 horses.

Advantage has been taken of the exposure of the bottom of Coachlace Pond to remove all stumps, roots and logs from the por-



Beginning of the CONSTRUCTION OF THE NORTH DIKE at Clinton.

Of the above amount of earth excavation, 83,500 cubic yards were obtained by stripping soil from the site of the reservoir.

Guard fences have been erected where necessary on both sections of the road. The total length of these fences is 13,500 linear feet, and they are nearly completed. The work of building the fences and of seeding the slopes of the embankments has been done by a day-labor force.

As the location of the Central Massachusetts Railway where it crosses the new road is to be abandoned, the new road is carried over the railroad on a temporary wooden bridge. After the railroad has been relocated, a permanent embankment can be substituted for the bridge.

The contract for constructing the temporary road already referred to, north of the easterly portion of the North Dike, was made with the Newell & Snowling Construction Company June 22, work was commenced June 24 and completed September 6. The maximum force employed was 47 men and 30 horses. The total quantity of earth excavated under this contract was 36,780 cubic yards, of which 24,220 cubic yards form a part of the North Dike, leaving only 12,560 cubic yards as the additional excavation required for the road.

Removal of Soil.

The removal of soil is one of the larger operations connected with the construction of the Wachusett Reservoir. The engineering and other work preliminary to this removal have been continued, and careful studies of methods of removal and of the division of the work into contracts have been made.

From January 1 to November 24 a force of men was employed in clearing the site of the reservoir of trees and brush. The number of acres cleared during the year was 535; 980 acres have been burned over, including 445 acres cleared the previous year. The work of clearing and burning now covers all of that portion of the site of the reservoir below Sawyer's Mills.

In connection with the construction of roads, the soil was stripped from 31 acres in 1898; and, as 41½ acres had previously been stripped of soil, the total to the end of 1898 is 72½ acres.

tion of the pond between the work included in the Gennaro contract and the temporary road. For this purpose a small day-labor force has been employed.

The entire site of the North Dike has been cleared of trees and bushes by a day-labor force.

RELOCATION AND CONSTRUCTION OF ROADS.

Various studies and preliminary estimates have been made for a highway across the reservoir at West Boylston, and for the relocation of the roads and railroads at Oakdale.

Topographical surveys for 3 miles of new roads have been made, 7¼ miles of located roads have been staked out, and the quantities of materials required for completing about 4 miles of roads have been estimated. Twenty-seven stone bounds have been set on the road locations.

A new road, about 9,000 feet long, has been built from the bridge over the Nashua River near the Lancaster Mills in Clinton, to connect with the portion of the same road constructed in Boylston in 1897. The two portions of the road have a total length of about 3 miles, and are all of the new road needed between Clinton and Boylston Centre. The work upon the whole road is now completed except for the broken stone surfacing, which still remains to be applied.

This road was given an extra width, so that it would accommodate a street railway. The tracks of the Worcester & Clinton Street Railway Co. have been laid, and cars are now running over the whole length of the road.

The contract for the portion of the road above referred to was made with T. H. Riddle & Co. May 10, they commenced work May 23 and completed the work December 1. The maximum force employed at any time was 259 men and 81 horses.

In order to build such a road as was desired in the location where the road necessarily ran, it was necessary to do a very large amount of work. This is indicated by the following approximate quantities of work done upon this portion of the road: —

Earth excavation,	164,379	cubic yards.
Slope paving and riprap,	2,741	" "
Masonry,	512	" "
Drains and culverts,	3,145	linear feet.

June 25, lowering Sandy Pond a little more than 15 feet and Coachlace Pond 8⅛ feet. The further lowering of Coachlace Pond could not be made without an inconvenient amount of digging through the ridge between the two ponds. The siphon was then removed, and the contractor finished the excavation.

Subsequently, two pipes, one 6 inches and one 8 inches in diameter, were laid through the cut to maintain the water in Sandy Pond at a low level. The 6-inch pipe was laid with the intention of extending it to a point further south, and where a water station for locomotives can be established. The 8-inch pipe is a waste pipe for the surplus water.

The price bid by Moulton & O'Mahoney for excavation under their contract was 14 cents per cubic yard. As this was the lowest price at which any excavation had ever been made upon the works, and as the contractors were willing to increase the length of railroad to be graded under their contract, the contract was extended to cover work not included in the original contract. The total length of railroad graded under their contract, and extensions, was 6,519 feet, and the total quantity of earth excavation was 69,124 cubic yards.

The road-bed is now completed from the North Dike to a point one-fourth of a mile south of Sandy Pond, except for short distances where the grading is to be done under the Gennaro contract for excavation at the North Dike.

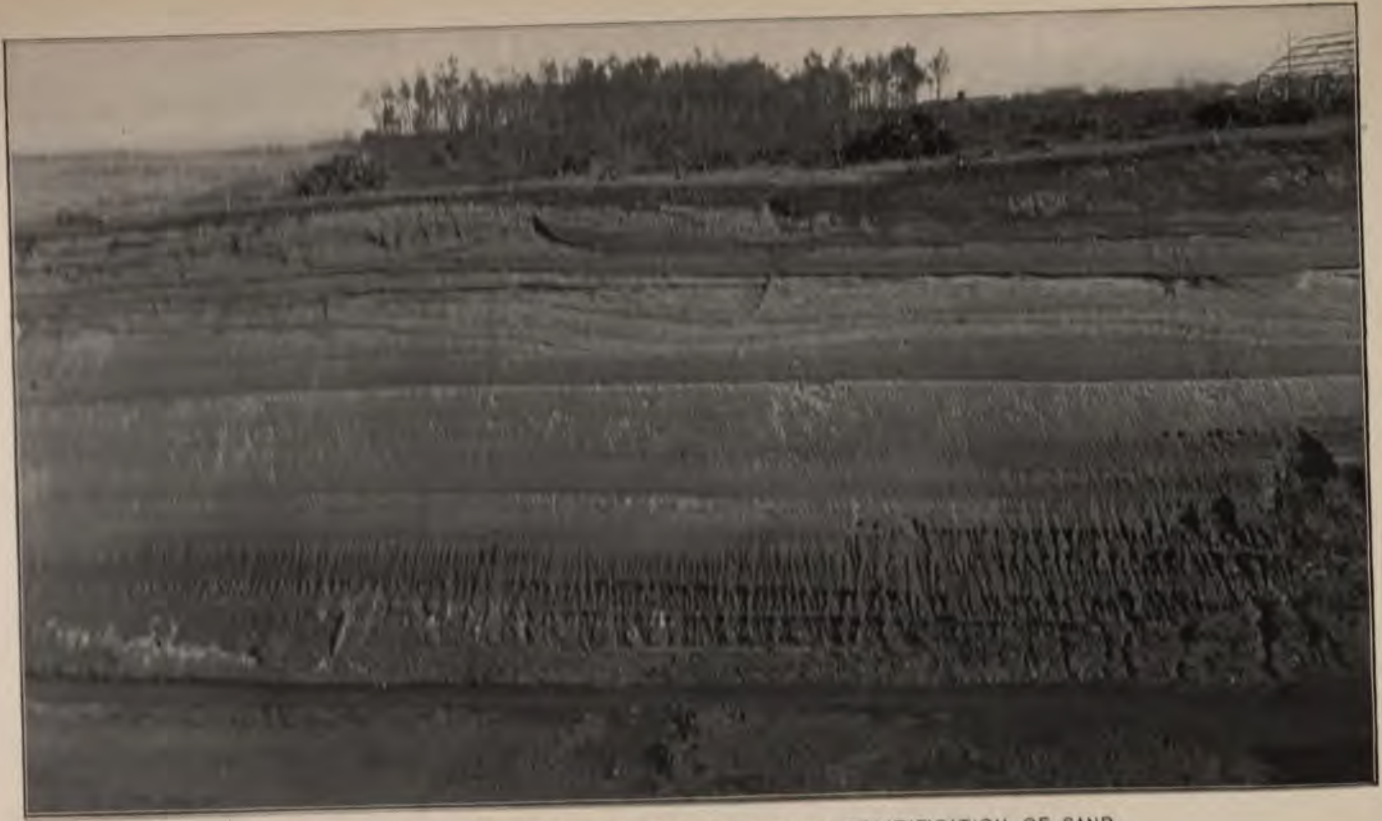
Moulton & O'Mahoney completed their work October 10, 1898.

LAND SURVEYS.

The field work of the surveys was substantially completed at the end of 1897. Since then 28 sectional plans, 24 inches high and 36 inches wide, have been made on a scale of 100 feet to the inch, making to date a total of 104 of these plans. Fourteen plans of the same size, on a scale of 300 feet to the inch, have also been made. Of all of these plans tracings have been made, and blue prints for use in the various departments of the Board.

Two hundred and eighty-three stone bounds and 9 iron bolts have been set to mark the margin of lands purchased or taken by the Board.

Taking plans for 5,375 acres of land at the Wachusett Reservoir have been prepared.



Excavation at the North Dike at Clinton, showing stratification of sand.

SANITARY INSPECTION.

Previous to the diversion of the water of the river into the Wachusett Aqueduct, the sources of pollution of the water on and near the site of the Wachusett Reservoir were investigated, and steps were taken for their abatement. Seventy-two cases of pollution from mills, buildings, hotels and barns have been abated. Since September 20 the camps of the contractors have been visited weekly by a medical inspector, to see if they are in a suitable sanitary condition and free from contagious diseases.

ADDITIONAL SURVEYS AND LEVELS.

One additional station has been added to the triangulation system at the reservoir. One hundred and twenty-six intermediate benches have been established between the precise bench marks. Plans and schedules of real estate acquired by the Commonwealth have been made for the assessors of Boylston and West Boylston. Gages established at the storage reservoirs on the watershed above the site of the main dam have been read from time to time, in order to determine the amount of water stored in or released from these reservoirs.

Some engineering and preliminary work was done in the early part of the year, in connection with the proposed disposal of the sewerage at Clinton. An account of this work is included in the report of the dam and aqueduct department, the charge of the work having been transferred to that department.

DAM AND AQUEDUCT DEPARTMENT.

THOMAS F. RICHARDSON, *Department Engineer.*

The work of construction in this department has related mainly to finishing the Wachusett Aqueduct, the building of works for the interception, pumping and disposal of the sewage at Clinton, and the construction of ditches for the drainage of swamps tributary to the open channel of the aqueduct.

The organization of the engineering force during the early part of the year remained substantially the same as at the end of the previous year; but, as work on the Wachusett Aqueduct approached completion, some of the engineers were transferred to other work.

Charles E. Wells, division engineer, has continued in charge of the work on the aqueduct and of the drainage of swamps in the vicinity of the open channel section of the aqueduct. Alexander E. Kastl, division engineer, was transferred to the reservoir department, as already stated. Horace Ropes, division engineer, after completing the work on his division of the aqueduct, has had charge of various investigations relating to future work. Ernest G. Hopson has continued as head draftsman at the Clinton office. Chester W. Smith continued in charge of the temporary dam and other work at the Nashua River until that work was completed, and has also been in charge of the construction of works for the interception, pumping and disposal of the Clinton sewage. David Hinckley, who was in charge of gagings and investigations, was transferred to the reservoir department on February 21, and his duties were assumed by John L. Hildreth, Jr. The engineering force, including engineering inspectors, in this department at the beginning of the year was 54, and in addition there was 1 masonry inspector. At the end of the year the force numbered 27.

The main office of the department has been in Clinton, and a branch office has been maintained at Northborough.

WACHUSETT DAM.

The engineers of the dam and aqueduct department have made studies for the location and design of the channel for conveying the overflow water from this dam. Twenty-eight additional wash-drill borings have been made along this channel for this purpose. They have an aggregate depth of 699 feet. This brings the total number of wash-drill borings at the site of the dam to date up to 849, having an aggregate depth of 16,354 feet. The engineers of the department have also made surveys and studies relative to the best height to which to raise the water in the Lancaster Mill pond, if it should be decided not to restore the dam to its original height.

Temporary Works. — The temporary dam for the purpose of diverting the water of the river into the Wachusett Aqueduct was substantially finished at the end of 1897, but work was actively progressing upon a small wooden flume for conveying water from the temporary dam to the head of the aqueduct. This flume was finished February 12. The gates at the temporary dam were closed on

February 19, and the water was allowed to rise behind it. Until the raising of the water behind this dam it was necessary to pump water from above the dam through a pipe which had been laid to the Lancaster Mills. The average amount of water pumped daily between January 1 and February 19 was 1,312,000 gallons. After February 19 the water flowed by gravity through the pipe to the mills. The gates of the small flume were first opened on March 7, 1898, to allow the Nashua River water to run into and through the Wachusett Aqueduct.

It has been necessary to do a considerable amount of protective work during the year, to prevent injury by freshets at the outlet into the river from the large flume of the temporary dam, at the Lancaster Mills dam, which had been partly torn down, and below the Lancaster Mills dam, where the concentrated current caused by the partial taking down of the dam had begun to erode the banks.

Wachusett Aqueduct.

The work to be done under the contracts for constructing the Wachusett Aqueduct, comprising 2 miles of tunnel through rock, 7 miles of masonry aqueduct (including the bridge across the Assabet River) and 3 miles of open channel, was finished at the end of 1897, except that considerable work remained to be done to complete the 3 miles of open channel. This work was not completed until March 7, 1898.

Section 11, — Open Channel.

The dams and bridges upon this section were completed before the cold weather at the end of 1897, but considerable earth and rock work remained to be done and riprap to be placed near the upper end of the section on January 1, 1898. The contractor continued at work, with a force varying from 315 men and 51 horses in January to 137 men and 35 horses on March 7, when the channel and practically all of the work required to be done under the contract was completed. There was a very heavy snow at the beginning of February, which materially delayed the work.

The final settlement with the contractors for the construction of this section has not yet been made.

Amount of Work done in Constructing Aqueduct.

The following statement gives the principal quantities of work of different classes done in connection with the construction of the Wachusett Aqueduct. It is a summary of the quantities from the final estimates, and does not include work done by the contractors as extra work, or work done subsequent to the completion of the contracts by a day-labor force.

CLASS OF WORK.	Quantity.	Cost.	Cost per Unit.
Earth excavation (cubic yards), . . .	1,073,967	$286,320 65	$0 27
Borrowed earth and soil dressing (cubic yards), ...	160,167	32,354 16	20
Overhaul (cubic yards), ...	1,255,440	9,415 80	00¾
Rock excavation (cubic yards), . . .	39,517	53,101 61	1 34
Tunnel excavation (cubic yards), . .	53,760	180,096 47	3 35
Dry filling over arch in tunnel (cubic yards),	4,379	6,568 50	1 50
Shaft excavation (linear feet), . . .	282	10,643 95	37 74
Coffer dam (linear feet), ...	521	3,428 18	6 58
Brick masonry (cubic yards), . . .	14,746	174,024 77	11 80
Brick masonry in tunnel (cubic yards), .	11,873	123,945 84	10 44
Rosendale cement concrete masonry (cubic yards), ...	54,703	209,786 29	3 84
Portland cement concrete masonry (cubic yards,.	34,786	175,038 27	5 03
Rubble stone masonry (cubic yards), . .	2,043	10,052 70	4 92
Rubble stone masonry in tunnel (cubic yards), ...	2,382	10,260 83	4 31
Dry rubble stone masonry and paving (cubic yards,.	728	1,091 55	1 50
Riprap (cubic yards), ...	4,198	7,297 23	1 74
Split stone masonry and paving (cubic yards), ...	1,277	21,044 01	16 48
Cut stone masonry (cubic yards), . .	1,688	40,021 82	23 71
Face dressing, pointed (square feet), . .	5,928	3,505 46	59
Face dressing, six-cut (square feet), . .	532	453 34	85
Cement plastering (square yards), . .	1,781	178 11	10
Lumber (feet B. M.), ...	320,285	9,551 37	29 82
Steel beams and fittings (tons), . . .	18	1,072 99	59 67
Railroad crossings, ...	2	2,000 00	1,000 00

Additional Work on Aqueduct in 1898.

As soon as the frost was out of the ground, day-labor forces were organized and were kept at work until late in the fall. The slopes and tops of all embankments, the slopes of many excavations and the surfaces of filled areas along the borders of the lower end of the open channel were graded and seeded with grass seed, and they are now covered with a fine, well-rooted sod.

Wooden fences have been built to protect the embankments from cattle, and guard fences, consisting generally of stone posts with chestnut guard rails fastened to their tops, have been built at highway crossings. In Northborough, where the highway crosses the aqueduct and the outlet from Bartlett Pond on an embankment, an iron fence has been built. Fences or walls have been built along the open channel lands where they are used for pasturage, and suitable drinking-places have been provided for the stock. Seventy-eight thousand one hundred and ninety-six linear feet, or 14.8 miles, of fence of various descriptions, and of stone wall, have been built.

Stone bounds have been set to mark the centre line of the aqueduct and the boundary lines of the land for the aqueduct.

Porcelain tiles, having black numbers upon them, have been built into the masonry on the inside of the aqueduct each 100 feet; and similar tiles, having names upon them, have been built into the masonry where culverts, highways and railroads cross the aqueduct.

Much work has been done to finally clear up and grade the grounds along the aqueduct, and to remove all débris left from the construction of the work. The number of men employed on this work has varied from 14 to 91, and the number of horses from 0 to 8.

WEST BERLIN WATER SUPPLY.

This water supply, completed at the end of 1897, as a substitute for wells which had been drained by the construction of the tunnel, has proved somewhat unsatisfactory to the people supplied with water; and, pending some improvement, a temporary supply has been obtained through the courtesy of the officials of the New York, New Haven & Hartford Railroad, from works constructed by the railroad company for supplying water to their locomotives.

CLINTON SEWERAGE.

At present the sewage of the town of Clinton is discharged directly into the Nashua River, at two principal outlets at points below the proposed Wachusett Dam. The diversion of the waters of the river for the use of the Metropolitan Water District will leave so little water to run down the river below the dam that a continuation of the present method of disposal would seriously pollute the waters of the stream, and probably cause a nuisance. It therefore is necessary that the sewage should be diverted from the river and otherwise disposed of.

During the early part of 1898 the surveys and investigations begun in 1897 were continued. As a result of all of the surveys and investigations, it was found that the best manner of disposing of the sewage was to filter it through sandy land in the southeasterly part of the town of Lancaster.

In June, the Legislature passed an Act entitled "An Act to authorize the Metropolitan Water Board to take lands in the towns of Clinton and Lancaster, and to erect and maintain thereon a plant for the disposal of sewage of the town of Clinton" (chapter 557, Acts of 1898). After the passage of this act, the engineers, under the instructions of your Board, proceeded forthwith to make plans for taking the land required for the sewerage works and to make detailed plans for the construction of the works.

The following is a description of the plans as finally adopted: —

An intercepting sewer, beginning at the existing sewer outlet which is farthest up stream, is to be constructed on the westerly bank of the river, so that it will intercept the other main town sewer near its outlet, and is then to extend still further north to a receiving reservoir to be built in the low land on the easterly side of High Street. The intercepting sewer will be 5,399.4 feet long, of which 4,279.3 feet will be vitrified sewer pipe 20 and 24 inches in diameter, and 1,120.1 feet will be a brick sewer 30 inches in diameter. The receiving reservoir is to be a covered circular structure, built of concrete, and capable of holding 600,000 gallons of sewage.

Adjoining the reservoir there will be a pumping station, at which the sewage will be raised by pumping about 49 feet. The sewage will be forced through an 18-inch cast-iron main about 2,290 feet long to a point within the land acquired for the disposal of the sewage; thence the sewage will flow by gravity through a system of vitrified pipes to 25 filter-beds located in the sandy plain on the easterly side of High Street, north of Mill Street.

In order to determine the best locations for the filter-beds, not only were careful surveys made of the territory, but 287 test pits, ranging in depth from 8 to 12 feet, were dug; and 24 wash-drill borings, having an aggregate depth of 440 feet, were made to determine the character of the underlying material and the elevation of the ground water. From the information thus obtained the filter-beds were located with reference to efficiency and economy. It was provided that all soil and loam overlying the sand should be removed from 19 of these beds, having an aggregate area of 17.5 acres; and that, on account of local conditions, but little soil and loam should be removed from the 6 remaining beds.

Plans were made of the land required for the purposes of these sewerage works, and the land was taken August 26, 1898.

Two contracts were made early in September for the construction of nearly the whole of the work, as follows: —

Section 1. — Filter-beds and appurtenances; contractor, Newell & Snowling Construction Company; approximate amount of contract, $19,022.20; date of contract, September 9, 1898.

Section 2. — Intercepting sewer, reservoir, pumping station foundations and force main; contractor, Owen Cunningham & Son; approximate amount of contract, $29,389.50; date of contract, September 8, 1898.

In addition to these larger contracts, other contracts were made for furnishing the pipe for the cast-iron force main and for furnishing and placing a steel bridge to support this pipe at the crossing over the Nashua River.

The contract for pipes was made with the Warren Foundry and Machine Company, July 5, 1898. The price bid was $16.60 per ton of 2,000 pounds delivered on the cars at Clinton.

The contract for the bridge was made with the New Jersey Steel and Iron Company, September 16, 1898. The price bid was $1,875 for the bridge in place.

The contracts for furnishing pipe and for the steel bridge have been completed.

The contract for Section 1 (filter-beds and appurtenances) is very nearly completed.

On Section 2 (intercepting sewer, reservoir, etc.) the work progressed substantially at the rate required by the contract until stopped by the cold weather. In the latter part of November, however, the junior partner, after collecting the money due upon the November estimate, disappeared, and has not since been heard from. By the terms of the contract, the work upon this section should be completed on or before June 15, 1899.

The maximum force employed on Section 1 was 139 men and 39 horses, and on Section 2 was 141 men and 9 horses.

DRAINAGE OF SWAMPS.

A beginning has been made during the year upon the work of draining the swamps tributary to the open channel, for the purpose of improving the quality of the water supplied from this part of the Sudbury watershed to the Sudbury Reservoir.

The swamps are generally very nearly level and frequently there are no well-defined water courses through them, and such water courses as exist are likely to be in the middle of the swamps. The water running into the swamps from the uplands has very little color, but in passing through the swamps takes up organic matter and acquires a deep brownish color.

In draining the swamps the general policy adopted provides for the construction of ditches near their edges to intercept the water from the uplands and to convey it to the reservoirs without deterioration. After completely isolating a swamp by the construction of such marginal ditches, it becomes moderately dry, as it receives little water except that which falls directly upon it as rain. The ditches are made of sufficient size to convey all water which is likely to reach them, except during times of extremely high flow. In some very narrow swamps only a single main ditch has been provided, instead of two marginal ditches. Where the ditches enter the open channel or other main stream, settling basins are provided to intercept matters carried along by the current of water in the ditches.

The work done upon this improvement to the end of the year was as follows: Surveys were made of 10 swamps, having an aggregate area of 660 acres. One of these swamps, known as "Crane Swamp," has an area of 431 acres. In addition to the swamps surveyed, there are four or five others tributary to the open channel, having an aggregate area of about 65 acres. The ditches which have been constructed have a bottom consisting of a 1-inch board 1 foot in width, with triangular rabbeted wooden strips on either side. These triangular strips make wooden sides to the channel about 3 inches high, serve as a footing for a stone paving at the sides of the channel, and will hold the boards in place after the nails used to hold them at first have rusted away. The side slopes of the ditches are 2 feet horizontal to 1 foot vertical, the depth of the ditches generally from 1½ to 2½ feet. The paving of small stones on the sides is built to a height somewhat above the surface of the water at its ordinary level.

The work was started on July 2 with a day-labor force, and the average force employed to the end of the year was 34 men and 3 horses. Fifteen thousand two hundred and thirty-one linear feet, equal to 2.9 miles, of ditches and 5 settling basins have been built.

ENGINEERING AND MISCELLANEOUS.

A large part of the time of the engineers of the dam and aqueduct department has been occupied in making various investigations.

Surveys in Quinepoxet Valley.

Among the works recommended by the State Board of Health for improving the quality of the water supply was included a system of main sewers for the villages and mills in the Quinepoxet valley. Up to the present time it has not been feasible to proceed with the construction of these works, but in the early part of the year, when an engineering force was available for the purpose, surveys were made to determine the best location for such sewers and in general the best methods for caring for the manufacturing wastes and the sewage of the small manufacturing villages and the village of Oakdale. Plans and profiles have been prepared and estimates of the costs of different methods proposed have been made, but the work is not yet completed.

Relocation of Central Massachusetts Railroad.

During the latter part of the year many additional surveys and estimates have been made relative to the relocation of this railroad. Three routes, which are different in whole or in part from routes previously considered, have been investigated, and estimates of cost have been prepared or are in progress.

Surveys of Meadows.

The owners of certain meadows in Clinton, Lancaster, Bolton and Harvard having made a claim for injury to their lands caused by the diversion of the waters of the Nashua River, plans have been prepared showing approximately all of the meadow lands in these towns which are subject to overflow by an average spring freshet.

The owners' names and the areas belonging to each are indicated on the plans. About 2,299 acres, belonging to 80 owners, are subject to such overflow.

Cement Tests.

Last year's report contained the tests of the cement used in the construction of the Wachusett Aqueduct in 1896 and 1897, amounting in all to 161,163 barrels. In 1898, 2,021 barrels were used and tested. Of these, 1,139 barrels were American natural cement, principally of the Hoffman brand, and 882 were American Portland cement, principally of the Iron Clad and Giant brands. The tests of the cement used in 1898 and additional tests of that used in 1896 and 1897 are given in Appendix No. 2.

Miscellaneous.

Many surveys and investigations have been made in this department for the purpose of obtaining information relative to the value of the water works taken from the city of Boston.

SUDBURY DEPARTMENT.

DESMOND FITZGERALD, *Department Engineer.*

The work of construction in this department during the year has related principally to the finishing of the Sudbury Reservoir. In addition to this work, a small settling reservoir has been built in connection with the proposed Marlborough filter-beds, and an additional siphon-pipe has been laid across the valley of Rosemary Brook, on the line of the Sudbury Aqueduct, to develop the full capacity of the aqueduct. Considerable work has also been done in the construction of a spillway channel and in grading the grounds below the Sudbury Dam.

The organization of the engineering force in this department during the year has not been changed, except by the addition of a small force on January 1, when the water works of the city of Boston were taken, and by the subsequent diminution of the force from time to time as different sections of the work were completed. At the beginning of the year the engineering force numbered 27, and at the end of the year there were 18 men in the force.

Edward S. Larned is still in direct charge of the work at the Sudbury Reservoir. Frederick Brooks, Daniel W. Cole, Benjamin

F. Goodnough, Walter W. Patch, Almon A. Platts and William Smiddy have been assistant engineers throughout the year, except that Mr. Patch was not employed for about three months in the winter and spring. Ellery C. Appleton, Frank A. Bayley and Bertram H. Davis have been assistant engineers for a portion of the year, but are not now engaged upon the work. Fred F. Moore is draftsman.

SUDBURY DAM.

This structure was practically completed at the date of the last annual report, but there still remained some grading and cleaning up of the grounds to be done, and the construction of a permanent channel at the foot of the spillway. Much of this work has been done by a day-labor force, which has graded the driveway leading to the dam, excavated the spillway channel and done other miscellaneous work.

On October 29, 1898, a contract was made with Mignault & McGrain for the construction of the spillway wall, which is to be 195 feet in length, and to consist of granite ashlar masonry backed with rubble and surmounted by a coping. The amount of this contract is $1,892. The work was begun early in November, and was far advanced toward completion at the end of the year.

SUDBURY RESERVOIR.

At the date of the last annual report the improvement of the reservoir by the removal of the soil and the deepening of the shallow portions was completed, with the exception of portions of sections A, M, O and Q.

On Section M the only work remaining to be done was the removal of some soft muck, which, by an agreement referred to in the last annual report, was to be removed by Washburn & Washburn in connection with their contract for excavating Section O.

In the case of Section A, it was feasible to complete the work in the reservoir before filling it in the spring of 1898, and the work on this section was consequently continued during the winter.

It was not feasible to complete the work on sections O and Q, so that an agreement was made with Messrs. Washburn & Washburn, contractors for both of these sections, under which the reservoir was to be filled in the spring, and they were to resume and complete the work after the drawing down of the reservoir later in the year.

On March 7, 1898, the water from the Nashua River entered the reservoir for the first time, and early in April it was practically full. The highest level reached by the water during the year was elevation 259.32 on May 17, when the water was passing over the spillway of the dam .32 of a foot in depth. On July 29 the supply of water to this reservoir from the Nashua River was stopped and the water was allowed to lower. On August 22 it had lowered sufficiently to permit the work of dredging upon sections O, Q and M to be resumed.

In the improvement of the reservoir the surface soil excavated was deposited in the shallow arms, forming large filled areas raised but two or three feet above the high-water line. In order to prevent the upland water from flowing over the surface of the filling, marginal ditches were constructed to intercept this water and convey it to the reservoir at appropriate points which were protected by paving.

Section A.

Auguste Saucier, the contractor for this section, continued his work during the winter under great disadvantages, as a large amount of the material was frozen, and had to be blasted before it could be excavated. On March 3 the work on that portion of the reservoir which was to be covered with water was completed. The work was then stopped until April 11, when the ground was sufficiently settled to allow the work of grading and seeding to proceed on those portions of the section comprised in the filling on the borders of the reservoir. On June 9 the whole of the work upon the section was completed.

As stated in the last report, the delay in completing this section was caused by legal complications, and not by a lack of diligence on the part of the contractor. He was therefore paid the extra cost of carrying on the work in the winter.

As this portion of the reservoir is adjacent to valuable estates and near the centre of the town of Southborough, the grounds were finished in such a manner as to harmonize with the surroundings.

Sections O and Q.

The remaining work on these sections was almost entirely connected with the excavation of a large swamp, and much of this swamp had already been excavated. The material was being removed by a pumping dredge, and forced through pipes into large shallow areas on the borders of the reservoir. On these areas, enclosed by dikes, the suspended mud settled to the bottom, and the comparatively clean water overflowed into a channel leading back to the dredge basin. The excavation of the material from the swamp was carried to a depth of 10 feet, or to a sand or gravel bottom if encountered at a less depth than 10 feet.

On August 22 the water in the reservoir had lowered sufficiently to permit the closing of the gaps in the small dikes which separated the dredge basin from the main reservoir. The dredging was resumed on this date, and was continued until November 2, when it was completed. A short time before the completion of the dredging, an opening was made in the dike farthest from the dredge, and the water in the dredge basin was allowed to flow out, so as to reduce the amount of water to be pumped later in order to expose the bottom for a final cleaning. The last part of the dredging consisted of the excavation of a large hole in the bottom of the swamp for the dredge to float in after the removal of the water from the dredge basin by pumping. The dredge, after the dredging ceased, was used to pump the water from the basin and expose the whole of the bottom. As the shores became exposed by the drawing down of the water, there was found to be a considerable deposit of mud or muck upon the sand or gravel, and a large force of men and teams was provided to remove it. Some of the material was very soft, and had to be collected in small piles and allowed to drain before it could be removed from the reservoir. Notwithstanding difficulties and interruptions by unfavorable weather and by snows, the mud and muck which rested upon a sand or gravel bottom were entirely removed by December 9.

Upon the completion of this work there were left 30 acres of mud surface, instead of the 75 acres in the original swamp. Moreover, it had been found in the preliminary examinations that the material 10 feet below the surface of the swamp contained much less organic matter than the material at the surface, and the excavation increased the depth of water from 12 to 22 feet. The material removed was necessary for the filling of the shallow arms of the reservoir.

After the completion of this work the water in the reservoir was raised by turning in water from the Nashua River; and when the water broke through the dikes to fill the dredge basin a considerable amount of sand was scoured out and deposited upon the mud bottom, and sand was also carried upon the mud by small streams during rains, so that a part of the mud is covered with sand.

Roads.

The roads built in Southborough and Marlborough in connection with the construction of the Sudbury Reservoir were kept in repair until accepted by the County Commissioners of Worcester County, on September 27, 1898. The County Commissioners inspected the roads on two occasions, and required that additional gravel should be put upon certain parts of the roads, and that stone walls should be moved or rebuilt upon other parts, but were willing to accept the roads if a settlement should be made with the town of Southborough by which the repairs and alterations would be made by the town. The question of the amount of compensation was left to be settled by the engineer of the town and the engineer of your Board.

It was agreed that the sum of $1,838.30 should be paid the town, and that the town should be given the right to take gravel from pits within the limits of the reservoir lands. The County Commissioners stated that the moving back of certain stone walls was rendered necessary by the use of a portion of the roads by the Framingham, Southborough & Marlborough Street Railway Company, which had recently laid a track through them. The railway company therefore reimbursed the Commonwealth for the cost of this portion of the work, amounting to $429.70.

In 1897 a circular dam was built in connection with the arch culvert under one of the roads which cross the southerly arm of the reservoir toward its upper end. This road leads from Southborough to Southville, and is locally known as the McQuarrie Road. The dam was built for the purpose of preventing the drawing down of the water in the portion of the reservoir west of the road, and when the water in the main reservoir is low, the road embankment acts as a dam.

It was one of the conditions of the agreement with the town of Southborough with regard to the acceptance of the roads, that the Commonwealth should "make good all such damage to that portion of said highway which has been so altered and elevated, the foundations, fences and riprapping, as the use of the said highway embankment as a dam shall cause, even though the action of other forces may contribute to the whole damage, and to indemnify and save harmless the said town for all loss, cost, damage and expenses resulting from said use." This agreement was dated September 8, 1898.

The following table shows the different road changes made in connection with the construction of the Sudbury Reservoir: —

	Entirely New (Feet).	Rebuilt (Feet).	Discontinued (Feet).
Framingham,	4,618	–	–
Marlborough,	–	1,895	–
Southborough,	7,000	25,760	44,450*

* This length of discontinued roads includes 4,800 feet of a town way, known as the "Turneycog Road," which was partly in Marlborough and partly in Southborough.

Sanitary Inspection.

As the number of men employed upon the construction of the reservoir diminished, it was found unnecessary to retain a special force of inspectors. On March 20 Claude P. Jones, M.D., resigned the office which he had so efficiently filled, and on April 20 the services of his assistant were dispensed with, and the sanitary inspection of the reservoir became a part of the work of the permanent inspection division, connected with the maintenance of the works.

Amount of Work Done in Constructing the Sudbury Reservoir.

The following table shows the quantities and the cost of the work done in the construction of the Sudbury Reservoir, exclusive of the dam. It is a summary of the quantities from the final estimates, and does not include the work done by the contractors as extra work, or some preliminary and additional work done by a day-labor force, neither does it include the cost of engineering. The quantities of work done by the city of Boston prior to January 4, 1896, when the reservoir was taken by the Metropolitan Water Board, under the provisions of the Metropolitan Water Act, are separated from the quantities of work done by the Metropolitan Water Board.

Table of Quantities and Cost of the Work done in the Construction of the Sudbury Reservoir.

	Done by City of Boston prior to January 4, 1896.	Done by Metropolitan Water Board, January 4, 1896, to December 31, 1898.	Total Quantities.	Total Cost.	Cost per Unit.
Earth excavation (cubic yards), . .	829,645.00	3,763,712.90	4,593,357.90	$1,197,340 20	$0 26
Rock excavation (cubic yards), . .	1,281.10	-	1,281.10	1,855 37	1 45
Voussoir masonry, in mortar (cubic yards).	-	157.47	157.47	3,464 34	22 00
Dimension-stone masonry, in mortar (cubic yards).	-	32.77	32.77	655 40	20 00
Ashlar masonry, in mortar (cubic yards),	-	341.00	341.00	5,456 00	16 00
Split-stone masonry, in mortar (cubic yards).	935.00	404.58	1,339.58	10,289 79	7 68
Split-stone masonry, dry (cubic yards), .	1,756.10	608.55	2,364.65	21,874 80	9 25
Rubble-stone masonry, in mortar (cubic yards).	-	1,188.41	1,188.41	6,170 05	5 19
Rubble-stone masonry, dry (cubic yards),	1,822.00	504.42	2,326.42	8,509 45	3 66
Rosendale concrete masonry (cubic yards),	835.55	802.34	1,637.89	8,576 54	5 24
Paving in mortar (cubic yards), . .	542.80	107.30	650.10	3,210 70	4 95
Paving (cubic yards), ...	-	174.77	174.77	349 54	2 00
Riprap (cubic yards), ...	2,784.40	31,921.31	34,705.71	36,398 79	1 05
Broken stone or screened gravel (cubic yards).	-	59.54	59.54	89 31	1 50
Coping (linear feet), ...	-	130.00	130.00	455 00	3 50
Dry paving (square yards), . . .	730.00	1,647.40	2,377.40	2,020 79	0 85
Stone wall (rods), ...	1,679.85	977.27	2,657.12	8,264 06	3 11
Iron fence (linear feet), ...	2,303.75	20,095.98	22,399.73	17,863 78	0 79⅜
				$1,332,843 91	

The total cost of the reservoir and dam to the end of 1898 was as follows: —

Reservoir, construction, ...	$1,576,155 06
Dam, construction, ...	645,186 45
Real estate and legal and expert services, . . .	616,770 27
Total, ...	$2,838,111 78

These figures for construction include the cost of day-labor work and engineering.

Settling Reservoir, Marlborough Filter-beds.

Walker Brook, one of the feeders of the Sudbury Reservoir, passes through the thickly settled portion of the city of Marlborough. The watershed of the brook at its entrance into the reservoir is about 2 square miles. As the quality of the brook water is bad, it is proposed to run it first through a settling reservoir, and afterwards filter it before permitting the water to flow into the reservoir.

The plans for the filter-beds are not yet completed, but the settling reservoir was built in 1898. It is situated just above the site of the proposed filter-beds, where there already existed a small artificial pond, the dam of which was much out of repair.

On July 23 a contract was made with Mignault & McGrain for the construction of the settling reservoir, and on November 5 the work was completed.

The reservoir covers an area of about 1.5 acres, has an average depth of 6 feet and contains 2,700,000 gallons. The bottom was graded with a slight inclination toward the centre, and finished with gravel to facilitate cleaning. There is a masonry sluiceway in the dam, 8 feet wide in the clear. This contains a set of stop planks to control the level of the water in the reservoir, and by removing them the water can be drawn down to clean the reservoir.

The earth excavation in constructing the reservoir amounted to 6,970 cubic yards, and 129 cubic yards of masonry were laid in the spillway. The amount of the contract was $2,380.45.

Rosemary Siphon Pipe.

The capacity of the Sudbury Aqueduct as originally constructed was limited by the capacity of two 48-inch siphon pipes laid across the valley of Rosemary Brook; but provision was made at the time the aqueduct was constructed for the addition of a third pipe whenever it should become necessary.

By raising the water in the aqueduct to the top of the arch at the up-stream end of the siphon, and forcing all the water possible through the existing 48-inch pipes, it was found that their capacity was about 80,000,000 gallons per day. As the consumption of water in the Metropolitan District was sometimes in excess of this amount, it became evident that the laying of an additional pipe was necessary.

Computations showed that it would be better to make the new pipe 5 feet in diameter, instead of 4 feet, as was originally intended; but it was also found that, by connecting the 48-inch pipe already laid through the wall of each of the siphon chambers with the new 5-foot pipe by means of tapering pipes, the capacity of the new pipe would not be materially affected.

Upon consultation with the pipe manufacturers, it was found that it would be more economical to use the outside molds already prepared for making a thick 5-foot pipe, and to produce the thinner pipe desired for the light pressures at the siphon by increasing the size of the core. The pipe, as actually delivered, therefore, was 61⅛ inches in diameter, and the thickness of the shell of the pipe was 1¼ inches. Although the pipe was thin for this diameter, no trouble was experienced either in shipping, unloading or laying it.

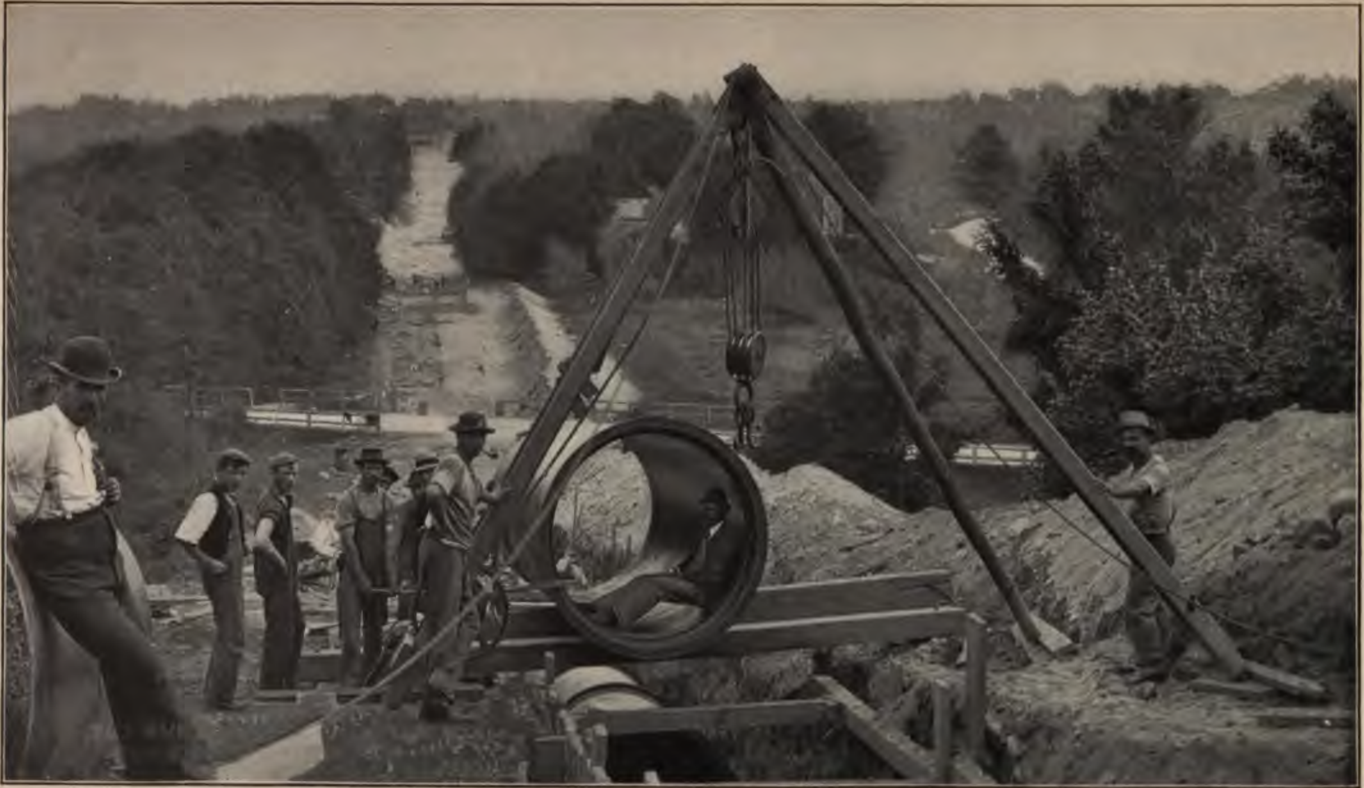
The contract for furnishing the pipe was made with the McNeal Pipe and Foundry Company on March 21, 1898, and the price bid was $18 per ton of 2,000 pounds, delivered on the cars at Needham.

On April 20 a contract was made with T. Tighe & Sons for the delivery of the pipes upon the ground. The price paid was $1.15 per ton.

On May 25 a contract was made with A. L. Norton & Co. for laying the pipes, and the work was completed November 17. The total amount of this contract was $4,986.63. The total length of the pipe between the siphon chambers was about 1,800 feet.

After laying the pipe the inside joints were filled with Portland cement mortar, to give a smooth and continuous surface to the interior of the pipe, and the pipe was tested for strength and tightness by plugging the ends and filling with water under a head of 30 feet of water in excess of the greatest head that can ever be brought upon the pipe in service. Under this head it was found that the maximum loss of water was at the rate of 12 gallons per day for the three days during which the pipe was under test.

After the pipe was put in use, experiments were made to determine its capacity; and it was found that, with the normal loss of head (1.73 feet), the discharge was about 54,600,000 gallons per day. In order to determine the value of c in the Chezy formula, $v = c\sqrt{rs}$, arrangements were made for taking exact measurements of the loss of head through a portion of the pipe 1,607.4 feet in length, which was laid either on a straight line or with vertical



Laying of additional SIPHON PIPE, 61 inches in diameter, ACROSS VALLEY OF ROSEMARY BROOK in Wellesley, connecting portions of Sudbury Aqueduct.

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curves having a radius of not less than 1,000 feet. The quantity flowing was determined by the ordinary methods used in measuring the flow through the aqueduct. It was found that the value of c ranged from 149.6 with a velocity of 4.65 feet per second to 154.3 with a velocity of 6.51 feet per second.

Daniel W. Cole was the assistant in immediate charge of the laying of this pipe. The total cost of the pipe was $23,034.05, or $12.80 per foot, including the cost of special castings, blow-off and valve at the lowest point of the siphon, and engineering and other expenses.

Engineering.

The work of the engineering force during the year has been principally in connection with the works already described. In addition to such work, however, many land plans have been made in connection with the settlement for the taking of lands. A contour plan of the Sudbury Reservoir, showing contours 1 foot apart, has been completed, and tables of areas and capacities of the Sudbury Reservoir for different elevations have been computed. Much work has been done, by boring and otherwise, to determine the character of the material at the site of the proposed Marlborough filter-beds, already referred to, and in designing these filter-beds. Surveys have been made of swamps tributary to Framingham Reservoir No. 3, with a view to their improvement by drainage. Several members of the force have been engaged most of the year in obtaining information relating to the value of the water works taken from the city of Boston.

DISTRIBUTION DEPARTMENT.

DEXTER BRACKETT, *Department Engineer.*

The work in charge of this department comprises the pipes, distributing reservoirs, pumping stations and all other works in the Metropolitan District, with the exception of Chestnut Hill Reservoir and the grounds about it and the Sudbury and Cochituate aqueducts.

During the year the work of laying the pipes required to distribute water to the several cities and towns in the Metropolitan Water District has been continued and is now nearly finished.

The distributing reservoir in the Middlesex Fells for the supply of the northern high-service district, and the low-service pumping station at Chestnut Hill Reservoir have been partially constructed. The extension of the high-service pumping station building at Chestnut Hill Reservoir has been completed. In this extension a 30,000,000-gallon Allis engine has been erected in readiness for service. Three 35,000,000-gallon engines for the low-service pumping station are in process of construction. Much work has been done in connection with plans and contracts for pumping stations, engines, boilers and other machinery. A contract has been made for a 20,000,000-gallon pumping engine to be located at Spot Pond, and proposals were received at the end of the year for the construction of the pumping station building at the same place.

The organization of the engineering force has been nearly the same as during the previous year, but the number of men employed has been somewhat less.

William E. Foss, John L. Howard, Caleb M. Saville and Alfred D. Flinn have been the assistant engineers in charge of surveys and construction, and Chester J. Wallace has been assistant engineer on surveys.

Alfred O. Doane has had charge of engineering work in connection with the pipe yards, the testing of pipe lines and the maintenance of the works.

Will J. Sando, in addition to the charge of the operation of the several pumping stations, has had charge of the inspection of the engines, boilers, valves and other machinery in construction.

George E. Wilde, assistant superintendent in the distribution department, in addition to taking direct charge of the maintenance and operation of the pipe lines and other works within the Metropolitan District, — with the exception of the pumping stations, — has also been in charge of such pipe-laying and other construction work as has been done by the maintenance force.

Inspectors have been employed at the several pipe foundries to inspect all pipes and castings made for the work.

The engineering force, including inspectors, numbered 53 at the beginning of the year, and the average number employed was 49. Under the supervision of the assistant superintendent of the department, a day-labor force, averaging 26 in number, has been employed in handling pipe at the pipe yards, laying pipes and testing pipe lines.

Pipes.

Six contracts for straight pipes and three contracts for special castings have been made during the year, and in addition several small orders have been given for pipes and special castings. Under these, and contracts uncompleted at the close of the year 1897, 5,130 tons of pipes and 474 tons of special castings were received at the pipe yards in 1898.

At the beginning of the year pipes were stored in yards at Edgeworth, Park Street in Somerville, Brighton and Forest Hills. On May 9, 1898, a lot of land containing 91,276 square feet, situated on the corner of Myrtle Street and Amaranth Avenue in Medford, was purchased for a permanent pipe yard and headquarters for the northern portion of the Metropolitan Water District. This lot is very near the Glenwood station of the Boston & Maine Railroad, and a side track has been laid into the yard for convenience in receiving pipes and other supplies. The yard has been graded and surrounded by a substantial picket fence 6½ feet in height; a macadamized driveway 500 feet in length has been built through the yard, and a derrick and scales have been provided for handling and weighing pipes. Plans are in preparation for a brick building to be erected in the yard, and used as an office, stable and shop.

In July the stock at the Edgeworth yard was transferred to Glenwood, and the use of the Edgeworth yard abandoned. In November the Park Street yard in Somerville was abandoned, all the pipes stored there, with the exception of about 100 tons, having been used in construction.

The following table gives the number of pipes and special castings received at the pipe yards from the foundries and used for pipe-laying during the years 1896, 1897 and 1898. Some of the figures for 1896 and 1897 differ from those given in the last report, on account of slight corrections.

136723

	Tons received 1896.	Tons received 1897.	Tons received 1898.	Tons used 1896.	Tons used 1897.	Tons used 1898.	Total received.	Total used.	On Hand.
61-inch, . .	-	-	768	-	-	768*	768	768*	-
60.5-inch, . .	-	-	566	-	-	-	566	-	566
48.5-inch, . .	-	1,311	-	-	1,286*	-	1,311	1,286*	25
48-inch, . .	27,950	14,294	-	16,458	20,210	3,697	42,244	40,365	1,879
42-inch, . .	25	2,327	-	-	2,271	-	2,352	2,271	81
36-inch, . .	1,732	8,670	462	-	5,725	4,316	10,864	10,041	823
30-inch, . .	1,458	37	73	490	903	16	1,568	1,409	159
24-inch, . .	529	3,159	46	481	2,315	41	3,734	2,837	897
20-inch, . .	2,516	1,893	152	1,349	2,049	205	4,561	3,603	958
18-inch, . .	-	-	151	-	-	151†	151	151†	-
16-inch, . .	1,230	125	2,542	694	611	2,412	3,897	3,717	180
14-inch, . .	-	12	-	-	-	2	12	2	10
12-inch, . .	133	264	336	10	224	378	733	612	121
10-inch, . .	20	-	6	1	14	9	26	24	2
8-inch, . .	15	20	9	6	16	13	44	35	9
6-inch, . .	11	56	18	11	32	27	85	70	15
4-inch, . .	-	30	1	-	9	6	31	15	16
Specials, . .	810	1,466	474	278	1,283	460	2,750	2,021	729
Totals, . .	36,429	33,664	5,604	19,778	36,948‡	12,501§	75,697	69,227	6,470

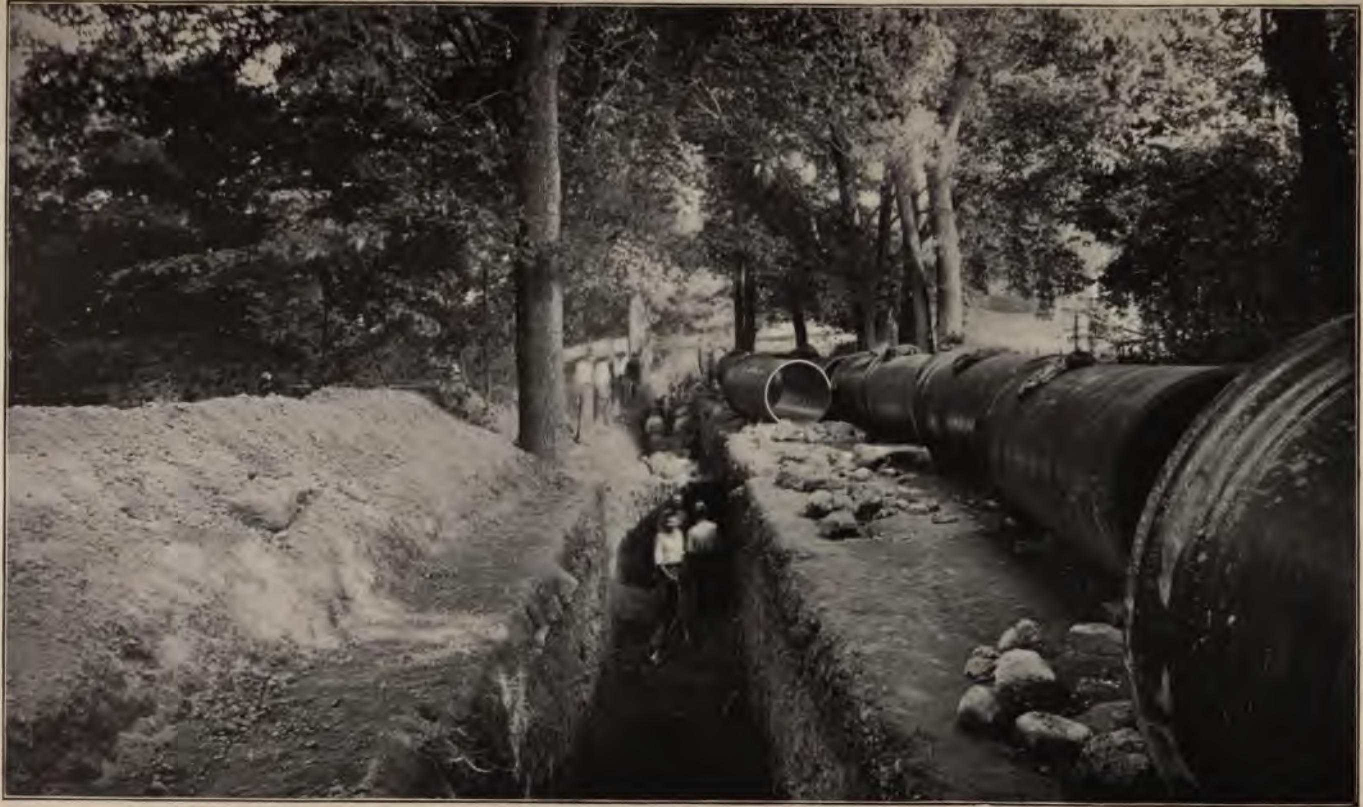
* Used by Sudbury department. † Used by dam and aqueduct department.

‡ 1,985 tons used by dam and aqueduct and Sudbury departments.

§ 1,008 tons used by reservoir, dam and aqueduct and Sudbury departments.

VALVES AND VALVE CHAMBER COVERS.

Two contracts for valves were made with the Camden Iron Works: the first, dated April 4, 1898, for furnishing seven 36-inch hydraulic lift valves and one 36-inch and one 48-inch check valve, amounting to $8,364; the second, dated August 29, 1898, for furnishing twenty-six valves from 12 to 20 inches in diameter, amounting to $2,882. One 48-inch valve costing $1,010, and twenty-five valves of sizes from 4 to 10 inches, were purchased from the Chapman Valve Company. A contract for furnishing cast-iron frames and covers for valve chambers was made with the Davis & Farnum Manufacturing Company on March 8, 1898, at $.0112 per pound, the whole contract amounting to $998.04.



Section of Reservoir Lane in Brookline during the LAYING OF THE 48-INCH PIPE.

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PIPE-LAYING.

During the year 14.43 miles of pipes have been laid, making a total of 57.18 miles laid in the Metropolitan District since the work was commenced.

On January 1, 1898, 0.75 miles of pipes in the vicinity of Chestnut Hill Reservoir, and 5.93 miles of pipes connected with the Mystic system of the city of Boston, were taken by the Metropolitan Water Board, and .03 of a mile has been abandoned during the year, making 63.83 miles now owned and operated by the Board in connection with the distributing system.

The aggregate length of the pipes in the several cities and towns supplied either wholly or in part from the Metropolitan Works was, at the close of the year, 1,180.74 miles, making, with the pipes owned by the Board, 1,244.57 miles in the distributing system. Connected with this system there are 125,578 service pipes, 9,485 water meters and 10,854 fire hydrants.

The pipes laid this year complete the distributing system to such an extent that a full supply of water can be furnished to every city and town in the Metropolitan Water District except Newton, Hyde Park and Nahant. The first two do not desire water at the present time, and Nahant was not admitted to the district until September 13, 1898. Soon after the admission of this town contracts were made for furnishing and laying the seven miles of pipes required for conveying the water from the pipes already laid in Revere, through Saugus and Lynn to the Nahant line. At the end of the year this work was completed with the exception of one thousand feet at the crossing of the Saugus River, where the work had to be delayed on account of a proposed change in the highway which would require the rebuilding of the bridge. It is expected that the whole work will be finished in the spring of 1899.

The principal items of pipe-laying work have been 7,934 feet of 48-inch pipes in Brookline and Jamaica Plain, and 17,413 feet of 36-inch pipes in West Roxbury and Dorchester, from Forest Hills to Milton, completing the southern high-service pipe line for the supply of Quincy and the high-service districts of West Roxbury and Dorchester. Three thousand and fifty-four feet of 48-inch pipes have been laid in North Harvard Street, Brighton, completing the 48-inch low-service pipe line between Chestnut Hill and the Mystic pipes near Tufts College. Fifteen hundred and forty-nine feet of 20-inch pipes and 5,008 feet of 16-inch pipes have been laid on the line to Watertown and Belmont, and 29,497 feet of 16-inch pipes, 2,933 feet of 12-inch pipes and 134 feet of 10-inch pipes have been laid in Revere, Saugus and Lynn for the supply of Nahant and Swampscott.

The following detailed statement describes the work done on the several sections into which the work has, for convenience, been divided: —

Section 1.

Low-service pipe lines in Chestnut Hill Reservoir grounds between pumping station and Chestnut Hill Avenue; double line of 48-inch pipes; length of section, 1,440 feet.

A contract for laying 2,080 feet of these pipes was made with Malone & McHale on October 21, 1897, and pipe-laying under the contract was finished December 30, 1897. During the first week of January, 1898, the valve chambers were finished, and there remained to be done the grading and cleaning up, which were left until spring. Work was resumed April 2 and completed April 16.

Sections 2, 3, 4 and 5.

Low-service pipe line from Chestnut Hill Avenue in Brighton through Beacon and St. Paul streets in Brookline, crossing Charles River, thence through Magazine Street, Massachusetts Avenue and Norfolk Street in Cambridge, Webster Avenue, Union Square, Bow Street, Walnut Street, Chauncey Avenue and the Middlesex Fells Parkway in Somerville, crossing the Mystic River to the city of Medford; total length of sections, 34,504 feet.

Work on these sections was completed in 1897 and described in the annual report for that year.

Sections 6 and 7.

Low-service pipe line from the Mystic River through Middlesex Avenue and Medford Street in Medford, crossing the Malden River, thence through Medford, Green and Jackson streets, private land, Pleasant and Washington streets, Ravine Road and private property to Spot Pond; total length of sections, 26,157 feet.

At the close of the year 1897 the work on these sections was completed with the exception of the crossing of the Malden River, for which a contract was made in October, 1897, with Moore & Co., and William H. Ward. The pipe-laying under this contract was finished on January 13, 1898, and the whole work completed on February 1. This work was described in the last annual report.

Section 8.

Low-service pipe line; this is a branch line, consisting of 7,174 feet of 48-inch and 8,052 feet of 42-inch pipes, starting from the junction of Medford and Bell Rock streets in Malden, and running through the cities of Everett and Chelsea to the crossing of Broadway and Williams Street, where connections are made with the pipes of the city of Boston supplying the East Boston district; length of section, 15,314 feet.

Work on this section was completed in 1897.

Sections 9, 10 and 11.

Low-service pipe line from Beacon Street in Brookline, through Winchester, Fuller and Harvard streets in Brookline, Harvard Avenue, Franklin and North Harvard streets in Brighton, crossing Charles River, thence through Boylston Street, Massachusetts Avenue and Beach Street in Cambridge, Willow Avenue in Somerville and Boston Avenue in Medford to the existing 24-inch and 30-inch pipes at College Avenue; total length of sections, 27,739 feet.

At the close of the year 1897 the work remaining to be done to complete these sections was the calking and testing of the pipes under the Charles River, and regrading of the trenches, by MacRitchie & Nichol, who were the contractors for the river crossing; the laying of 3,054 feet of 48-inch pipes in North Harvard Street, which was not done in 1897 on account of the proposed widening of the street; and the making of connections with the 30-inch and 24-inch Mystic pipes at the junction of Boston and College avenues.

MacRitchie & Nichol resumed work on the river crossing on April 11. The pipes were satisfactorily tested on April 30 and the work under their contract was completed May 16.

The widening of North Harvard Street having been ordered by the city of Boston, a contract was made on August 11 with Bruno & Salomone for laying the pipes between Franklin Street and the river. The pipe-laying was finished on October 19 and the whole work completed on November 14.

The work of making the connections with the Mystic pipes was done by a day-labor force between March 29 and April 4, 1898.

Section 12.

This section, which includes the continuation of the 48-inch pipe line from the junction of College and Boston avenues to Spot Pond, will not be laid at present; but, in order to avoid future disturbance at the bridge over the Mystic River in Medford, built to support both this pipe line and the 20-inch high-service line, 439 feet of 48-inch pipes have been laid over the bridge and on either side of the river. This work, done by Cheney & Trumbulls, was in progress at the date of the last report, and was completed on January 14, 1898.

Sections 13, 14, 15, 16 and 17.

Northern high-service pipe line, extending from the proposed pumping station at Spot Pond to the reservoir in the Middlesex Fells, thence through the cities of Malden, Everett and Chelsea and the town of Revere to Breed's Island, with branch lines extending to the reservoirs in Chelsea and Revere; total length of sections, 51,222 feet.

During the past year 2,052 feet of 12-inch pipe were laid on Section 16 by H. A. Hanscom & Co., from the Revere line, through Beachmont and Leverett avenues and Walley Street to the mains of the Boston Water Works on Breed's Island. This work, which was begun May 17 and finished June 3, practically completed these sections.

Section 18.

Northern high-service pipe line, from Highland Avenue in Malden, through Malden, Medford and Somerville to the crossing of Broadway and Cedar Street, where it connects with the Somerville pipe system; length of section, 19,633 feet.

The pipe-laying on this section was nearly all done in 1896 and 1897. The bridge which carries the pipes across the Mystic River was nearly finished in 1897, but not entirely completed until the spring of 1898. Where College Avenue crosses the Southern Division of the Boston & Maine Railroad, the railroad company rebuilt the highway bridge and its abutments. In building the abutments it extended them so as to provide the abutments for a pipe bridge upon the payment by the Commonwealth of $1,000. The pipe bridge, consisting of two steel plate girders, 79.6 feet in length with the necessary floor beams and wood work, was furnished and erected by the Pittsburg Bridge Company for $3,097. This bridge is designed to carry a 48-inch pipe and a 20-inch pipe, although only the 20-inch pipe has been laid. The bridge was delivered on the site of the work on May 9, and the entire work was completed on June 27. The laying of the pipes across the bridge to connect with existing pipes — a total length of 200 feet — was done by the maintenance force, which also made connections with the main pipe of the city of Somerville on December 3.

Section 19.

Southern high-service pipe line, from the Chestnut Hill pumping station through Reservoir Lane, Boylston Street, Boston Water Works grounds, Dudley, Warren and Cottage streets in Brookline, and the Parkman Drive and the Arborway in West Roxbury, to South Street, near the Forest Hills station on the New York, New Haven & Hartford Railroad; 18,362 feet of 48-inch pipes.

A contract for laying 15,335 feet of these pipes was made with E. W. Everson & Co., August 3, 1897, and they laid 10,184 feet of this line during the year 1897. They resumed work March 16, and completed the pipe-laying July 12 and the entire work September 3.

A contract was made with Bruno & Salomone, June 22, 1898, for laying 2,783 feet of 48-inch pipes in Reservoir Lane and Boylston Street. Work was commenced June 29; pipe-laying was completed September 12 and the whole work October 1. As Reservoir Lane is a private way, a taking was made of the strip of land in which the pipes were laid. The lane is narrow and crooked, but plans have been made for widening and straightening it. It was decided to place the pipes with reference to the future location of the lane; and, in order to do so, it was necessary to lay the pipes at some points in private lands adjoining the lane, cutting down some of the trees and removing portions of the stone walls and fences along the property lines. After the pipes were laid, substantial fences were built where the walls had been removed. Considerable work was done in improving the roadway, and it is in much better condition now than before the pipes were laid.

In order to complete this section, a short length of pipe remained to be laid from the end of the pipe laid by Bruno & Salomone across the Boston & Albany Railroad to the Chestnut Hill pumping station. This work comprised connections with the discharge pipes from engines Nos. 3 and 4, the setting of a large number of special castings and valves and the crossing of the Cochituate Aqueduct, in addition to the railroad crossing already mentioned. The work was done by the maintenance force.

Section 20.

Southern high-service pipe line, from South Street in West Roxbury, through the Arborway and Morton Street in West Roxbury and Dorchester, to River Street; 17,380 feet of 36-inch pipes.

A contract for laying these pipes was made with H. A. Hanscom & Co. on May 11, 1898. The work was begun May 21 and the last pipe was laid December 3. The work is finished, with the exception of a small amount of street surfacing to be done when the weather will permit. A large quantity of ledge and water made the construction of this line slow and expensive. Stony Brook in the Arborway near Washington Street was crossed over by a self-supporting 36-inch riveted steel pipe 37.9 feet in length. At the crossing of the Midland Division of the New York, New Haven & Hartford Railroad the pipes were carried outside the line of the street and under the tracks.

Several difficult brook crossings were made on this line. About 300 feet of embankment were built over the pipes where the location was outside existing street lines, and about 1,100 feet of gas pipes were relocated. A connection was made with the city of Boston pipes in South Street.

Section 21.

Southern high-service pipe line, from the corner of Morton and River streets in Dorchester, through River Street, across the Neponset River, through Adams Street in Milton and Quincy, and Beale Street and Summit Avenue in Quincy, to the site of the proposed reservoir and stand-pipe on Forbes Hill; 15,659 feet of 24-inch pipes.

A contract was made with Saucier & O'Brien September 2, 1897, for laying these pipes, and they laid 14,814 feet during the year 1897. Work was resumed by the contractors April 4. The pipes were laid across the Neponset River and over the New York, New Haven & Hartford Railroad, and the short gaps at East Milton and Quincy were closed. The whole work was completed July 2.

At the crossing of the Neponset River the pipes are enclosed in a box to keep the water from freezing in cold weather. At the crossing over the New York, New Haven & Hartford Railroad two lines of 16-inch pipe were laid in place of one line of 24-inch pipe, so that the pipes could be laid below the surface of the bridge.

A connection was made with the pipes of the city of Quincy at the corner of Adams and Beale streets in July.

Section 22.

This section consists of the branch which leaves the main pipe line leading to Quincy at the corner of Morton and River streets in Dorchester, and runs to Hyde Park. About 7,000 feet of 24-inch and 9,000 feet of 20-inch pipes for this line, purchased in 1897, are now stored at the Forest Hills pipe yard but no contract has been made for laying the pipes.

Section 23.

Southern high-service pipe line, from the Chestnut Hill pumping station, through Beacon, Hammond and South streets, Commonwealth Avenue and Ward Street to the old distributing reservoir of the Newton Water Works; length of section, 8,270 feet.

In 1897, 7,450 feet of 36-inch pipes were laid on this section, leaving unfinished 403 feet connecting with Section 19 at the Chestnut Hill pumping station, and 417 feet in Ward Street near the Newton line. Pipes filling both of these gaps were laid by the maintenance force between September 21 and October 21.

Section 24.

Southern high-service pipe line, from the Newton Reservoir, through Ward Street, Waverley Avenue, Washington and St. James streets in Newton, across private land and the Charles River to Watertown, and through Irving and Mount Auburn streets in Watertown to Palfrey Street; 12,691 feet of 20-inch pipes.

S. W. Frescoln laid 11,142 feet of these pipes in 1897. The remaining 1,549 feet comprised 1,145 feet near the crossing of the Charles River, 231 feet in Ward Street near the Newton Reservoir, 169 feet at the crossing over the Boston & Albany Railroad at St. James Street in Newton, and 4 feet which were laid in connection with Section 25.

A contract was made with E. W. Everson & Co. for laying the pipes at and near the crossing of the Charles River. Work was commenced June 17, 1898, and finished September 15. For the river crossing, which is about 300 feet in length, pipes 1 inch in thickness were used. The pipes were laid with their tops about 8.5 feet below mean high tide, or 5.5 feet below the bed of the river, except for a distance of about 100 feet, where they were laid 4 feet lower, to provide for a future channel. The trench was excavated in the gravelly clay of the river bed by means of an excavator, which was designed and used for excavating pipe trenches upon the land. The excavated material was piled at the sides of the trench, forming a dam, the top of which was 2 feet below high tide. The excavator was set upon blocking, so that it could be operated at almost all stages of the tide, and the water was pumped from the trench and the pipes were laid and calked while the tide was below the level of the top of the dam. The bridge over the Albany Railroad was placed in position by the Boston Bridge Works on January 9, 1898. The pipes at the railroad crossing and the pipes in Ward Street near the Newton Reservoir were laid by the maintenance force.

Section 25.

Southern high-service pipe line, from the end of Section 24, near the corner of Irving and Mount Auburn streets in Watertown, through Mount Auburn and Common streets to the pipes of the town of Belmont near the crossing of Common Street and Trapelo Road; 5,008 feet of 16-inch and 455 feet of 12-inch pipes; length of section, 5,463 feet.

These pipes were laid by Michael Russo, under a contract dated July 22, 1898. Work was begun August 1 and completed October 15. At the connection with the pipes of the town of Watertown a 10-inch pressure reducing valve has been set by the maintenance force.

Section 26.

Northern high-service pipe line, extending from the corner of Broadway and Beach Street in Revere, through Broadway in Revere and Western Avenue in Saugus to a point in Lynn about 250 feet north of the bridge crossing the Saugus River between Saugus and Lynn; length of section, 19,200 feet of 16-inch pipes.

A contract for laying these pipes was made on September 19, 1898, with Mirick & Wentworth, and the work was commenced October 6. No special difficulties were encountered, and on December 20 the pipe-laying was finished, with the exception of a section 1,000 feet in length crossing the Saugus River, where the work was delayed on account of proposed changes in the location of the road and bridge. These changes have now been decided upon, and it is expected that the work will be finished in the spring.

Section 27.

Northern high-service pipe line, extending from a point on Western Avenue in Lynn about 250 feet north of the bridge crossing the Saugus River, through Western Avenue, Summer, Market, Broad and Washington streets to the pipes of the towns of Swampscott and Nahant near the Lynn-Nahant line; 11,251 feet of 16-inch and 3,067 feet of 12-inch pipes; length of section, 14,260 feet.

A contract for doing this work was made with O'Rourke & Nelson on September 19, 1898. Work was begun on October 3 and stopped for the season on December 28. The pipe-laying has been completed, with the exception of making the connections with the pipes of the towns of Swampscott and Nahant. These pipes were laid through several of the principal streets of the city of Lynn, and the work was delayed and its cost increased by obstructions, such as sewer connections, stone culverts and abandoned steam-heating pipes, of which, in many cases, no record was to be found. The pipe-laying was finished so late in the season that considerable work of repaving and resurfacing streets must be done in the spring after the frost leaves the ground.

Statistics of Pipe-laying.—Principal Items of Work done by Contract and Day Labor to December 31, 1898.

	Total to Dec. 31, 1897.	Work done in 1898.	Total to Dec. 31, 1898.
48-inch pipe laid (feet),	109,332	11,475	120,807
42-inch pipe laid (feet),	8,075	-	8,075
36-inch pipe laid (feet),	24,425	18,923 *	43,257
30-inch pipe laid (feet),	7,418	81	7,499
24-inch pipe laid (feet),	19,675	695	20,370
20-inch pipe laid (feet),	35,893	2,156	38,049
16-inch pipe laid (feet),	17,362	34,675 †	51,941
14-inch pipe laid (feet),	3	23	26
12-inch pipe laid (feet),	3,284	7,883	11,167
Rock excavation (cubic yards),	11,162	4,606	15,768
Earth below grade (cubic yards),	4,005	697	4,702
Valve chambers built,	325	162	487
Concrete masonry (cubic yards),	767	208	975
Piles driven,	2,553	76	2,629
15-inch sewer pipe laid (feet),	33	-	33
12-inch sewer pipe laid (feet),	3,856	-	3,856
10-inch sewer pipe laid (feet),	2,967	-	2,967
8-inch sewer pipe laid (feet),	2,171	-	2,171
Sewer man-holes built,	51	-	51

* Ninety-one feet 36-inch pipe taken up.

† Ninety-six feet 16-inch pipe taken up.

Table showing Length of Main Lines and Connections and Number of Valves set in Same.

	DIAMETER OF PIPES IN INCHES.												Totals.
	48.	42.	36.	30.	24.	20.	16.	14.	12.	10.	8.	6.	
Length laid to January 1, 1898 (feet),	109,382	8,075	24,426	7,418	19,676	35,893	17,862	3	3,284	100	28	18	225,703
Gate valves in same, ...	21*	–	14	9	12	14	18	–	10	–	–	1	99
Air valves in same, ...	56	3	15	3	7	20	8	–	2	–	–	–	114
Length laid during 1898 (feet), .	11,475	–	19,014	61	695	2,156	34,675	23	7,883	168	16	30	76,211
Gate valves in same, ...	6†	–	10	3	6	4	16	1	10	2	1	–	59
Air valves in same, ...	10	–	16	–	1	3	16	–	1	–	–	–	47
Length taken during 1898 (feet), .	730	–	1,185	19,551	10,832	–	–	–	1,554	–	701‡	710‡	35,263
Gate valves in same, ...	5	–	6	5	7	–	–	–	7	1	2	8	41
Air valves in same, ...	–	–	–	1	–	–	–	–	–	–	–	–	1
Length abandoned during 1898 (feet),	–	–	91	–	–	–	96	–	–	–	–	–	187
Gate valves in same, ...	–	–	–	–	–	–	–	–	–	1	–	–	1
Total length operated January 1, 1899 (feet), ...	121,587	8,075	44,588	27,030	31,203	38,049	51,041	26	12,721	858	745	758	336,990§
Gate valves in same (total), . .	32	–	30	17	25	18	34	1	27	2	3	9	198
Air valves in same (total), . .	66	3	31	4	8	23	24	–	3	–	–	–	162

* 36-inch valves. † 6 are 36-inch valves. ‡ On grounds at Chestnut Hill and Mystic pumping stations. § 63.8 miles.

Statement of Cast-iron Hydrant, Blow-off and Drain Pipes laid to January 1, 1899.

	Diameter of Pipes in Inches.						Total.
	24	16	12	8	6	4	
Length laid to January 1, 1898 (feet), .	-	1,812	1,185	24	570	339	3,930
Length laid during 1898 (feet), . . .	352	122	727	-	175	255	1,631
Length taken during 1898 (feet), . .	-	-	975	-	560	225	1,760
Length abandoned during 1898 (feet), .	-	-	-	-	-	100	100
Total length in use January 1, 1899 (feet), .	352	1,934	2,887	24	1,305	719	7,221
Valves set to January 1, 1898, . . .	-	14	34	-	22	8	78
Valves set during 1898, ...	-	1	12	-	3	12	28
Valves taken during 1898, ...	-	-	3	-	9	11	23
Valves abandoned during 1898, . . .	-	-	-	-	-	5	5
Total valves in use January 1, 1899, . .	-	15	49	-	34	26	124

SPOT POND.

The only construction work done at the pond has been in connection with the inlet conduit and the substructure of the gate-house. This work was in progress at the date of the last annual report, and was completed during the month of January.

The Coffin Valve Company, which furnished and erected the sluice gates in the gate-chamber, began setting the gates on January 19, 1898, and on January 25 all the gates were in working order.

The 24-inch cast-iron pipe which is to be used as a waste pipe from the pond, as well as a drain from the pumping station, gate chamber and pipes, was extended through the Virginia Wood in October, by the maintenance force, for a distance of 350 feet. At the end of this pipe a weir was built for measuring the quantity of water wasted from the pond.

NORTHERN HIGH-SERVICE RESERVOIR.

This reservoir, to which water is to be pumped from Spot Pond, is to be the distributing reservoir for the northern high-service district. The site is a natural basin about 500 feet northeasterly from the highest point in the southerly portion of the Middlesex

Fells Reservation, known as Cairn Hill, and about 2,500 feet southeasterly from Spot Pond.

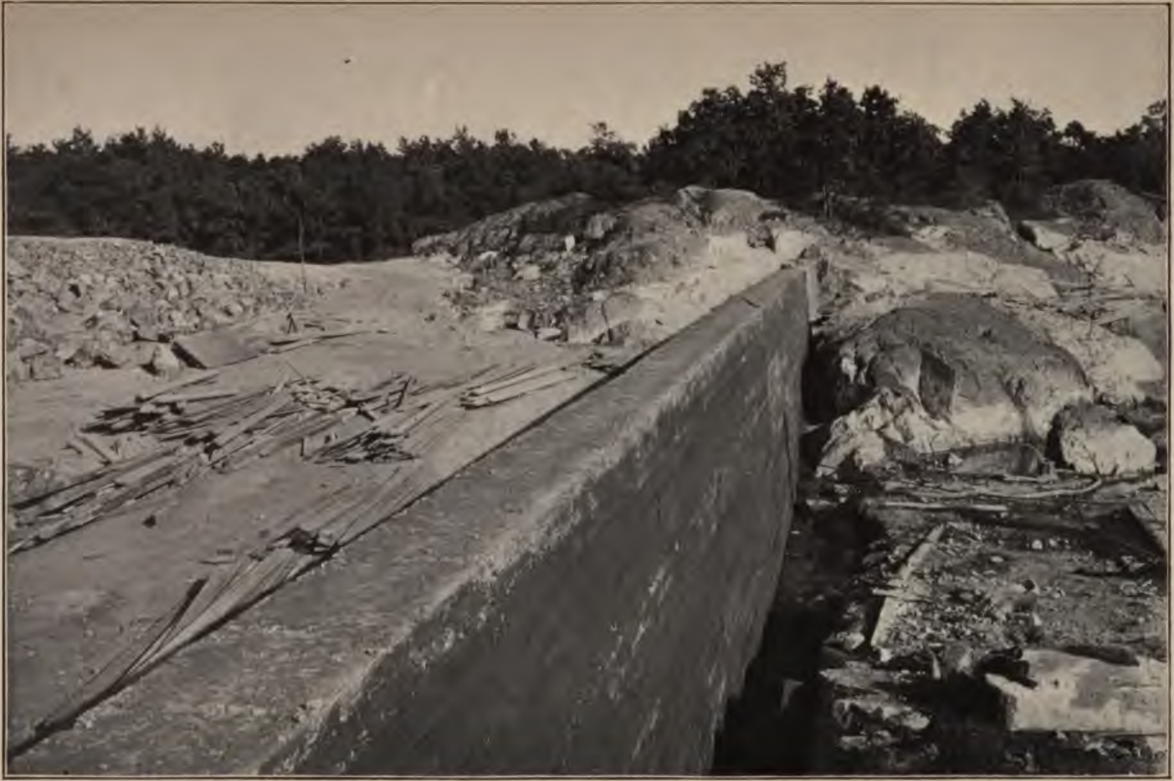
The site was an alder swamp, which, by the construction of five dams having an aggregate length of about 930 feet, is to be converted into a reservoir having an area of 8.2 acres and a capacity of 38,500,000 gallons. By utilizing a natural ridge of rock and constructing two short walls of concrete masonry, the reservoir will be divided, when drawn down 6 feet below high water mark, into two basins.

As the reservoir is located within the limits of the Metropolitan Park Reservation, landscape considerations had considerable weight in determining the outline and general treatment of the work. The natural surface of the rock is to form the shore line of the reservoir except at the dams, and at those points the shore is to be finished as a gravel beach, and the embankments are to be graded so as to give a natural appearance, instead of the usual artificial appearance of reservoir embankments. This grading is to be done in accordance with plans furnished by Olmsted Brothers, landscape architects, whose advice was also secured regarding the location of the various dams and the gate-house.

A contract for building the reservoir was made on May 7, 1898, with T. W. Kinser & Sons of Waltham. On May 20 the contractor commenced clearing the ground of trees and bushes, pulling stumps and removing soil from under spoil banks. A road about 1,200 feet in length was built from the park roadway to the reservoir site, in order to furnish a way for bringing materials for the work.

For removing muck from the reservoir the contractor used a Hayward excavator, loading the material into cars which were hauled up an inclined track to the dump by means of a stationary engine. The excavator worked successfully, but, on account of the soft nature of the material and the amount of water in it, great difficulty was experienced in handling it on the dump. For furnishing broken stone for the concrete a stone crusher was set up which commenced work on August 9.

The first concrete was put in place August 22 in the core wall of Dam No. 4, and, during the two months following, work upon the core walls and embankments of four of the dams made fairly good progress. Work upon the gate-chamber and walls between the basins was, however, delayed on account of the failure of the con-



Core Wall of the EASTERLY DAM of the High-Service Reservoir in the Middlesex Fells.

tractor to obtain a supply of Portland cement, and the work as a whole did not progress satisfactorily or nearly at the rate required by the provisions of the contract. On October 21 the contractor stated that, owing to financial difficulties, he would be unable to continue work under the contract, and he presented a statement showing that the cost of the work up to that time was very greatly in excess of the amount received for doing the work. An agreement was made between the Board and the contractor for the discontinuance of work, but it was also provided in the agreement that he should continue the work until a new contract could be made, he to receive the cost of the work done after October 21. The work was relet as soon as possible. Nawn & Brock were the lowest bidders, and a contract was made with them on November 4; they began work November 5, and succeeded before freezing weather in doing all the work necessary to protect the masonry already built from freezing. At the end of the year the concrete masonry core walls of four of the dams were finished and covered with earth.

The principal items of work done on the reservoir to December 15, the date of the latest estimate, were 62,087 cubic yards of earth excavation, 5,979 cubic yards of rock excavation and 2,133 cubic yards of Rosendale cement concrete masonry.

A contract for furnishing sluice gates, steel beams and cast-iron floor plates for the gate-chamber of this reservoir, amounting to $3,420, was made with the Coffin Valve Company on August 11, 1898. Satisfactory progress has been made on this work; eight 36-inch sluice gates are now finished ready for erection and a large part of the floor plates have been cast and machined.

Southern High-service Pumping Station.

During the year the extension of the pumping station, upon which work was in progress at the date of the last report, has been completed, with the exception of laying the floor of the engine room. C. A. Dodge & Co., the contractors for the extension, continued work during the winter of 1897–98 when the weather would permit, and early in May the slating and inside sheathing of the roof were completed. During the months of May and June the outside walls of the building were pointed, the windows and the woodwork, with the exception of the doors and engine room floor, finished, and the basement drains completed. Since July 1, as work upon the engine has permitted, the terra-cotta floor arches and spruce underfloor have been built, the granolithic floor has been laid in the basement, the basement ceiling plastered and the doors hung and painted.

The steel roof trusses were furnished and erected by Edward Kendall & Sons, who began work about January 15 and completed their contract on April 5.

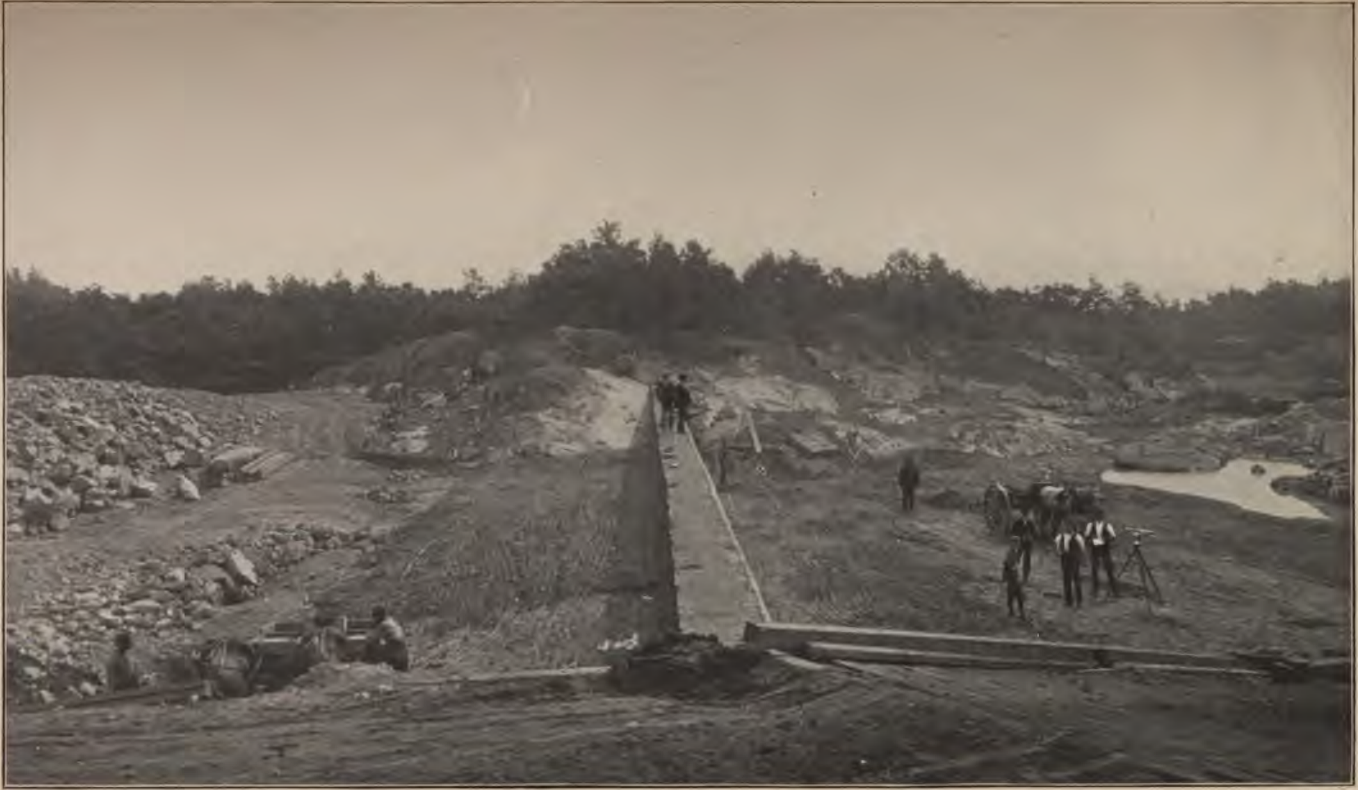
A 15-ton hand-power travelling crane was furnished and erected by the Brown Hoisting and Conveying Machine Company of Cleveland, O., for the sum of $1,930, and has been of great assistance in the erection of the new engine.

The first shipment of castings for the pumps of the new 30,000,000-gallon engine, for which a contract was made with the E. P. Allis Company on January 1, 1897, was received on March 28, 1898, and the work of erection was begun at once by the contractor. The engine bedplates arrived about the middle of August, and since that time the work of erecting the engine has been pushed as rapidly as possible. On December 11 the engine was operated for the first time, and, although the non-conducting covering, lagging and electric light wiring have not yet been finished, the engine can be used when necessary.

The 90-inch Belpaire boiler, for which a contract was made with the Lake Erie Boiler Works on September 1, 1897, was delivered at the station on March 13, and was set and connected ready for use on April 24. The concrete foundations for this boiler were built by the maintenance force.

In February a contract was made with the Wm. H. Gallison Company for furnishing and erecting the steam pipe connecting the Belpaire boilers and the new engine. This work was finished in May, with the exception of a short length connecting with the engine. This connection could not be made until the engine was erected, and is now under construction. The non-conducting covering for the steam piping has been furnished and applied by the H. W. Johns Company. This work has been nearly finished.

The extension of the heating system in the addition to the building, and the erection of the feed and miscellaneous small piping required in connection with the new boiler and engine, also the electric light wiring required in connection with the new engine, have been done by the regular force of engineers and machinists employed at the station.



Core Wall and partially constructed Embankment of the Easterly Dam at the High-Service Reservoir in the Middlesex Fells.

LOW-SERVICE PUMPING STATION.

In May the buildings and sheds located on the site of the proposed low-service pumping station at Chestnut Hill Reservoir were moved to other parts of the grounds, and about 800 cubic yards of stone piled on the land were crushed by the maintenance force, using the stone crusher already in place belonging to the city of Boston. During the summer the maintenance force removed the shrubbery and loam, and worked upon the basement excavation when not employed upon other work.

On August 26 a contract was made with Norcross Brothers for building the superstructure of this pumping station, in accordance with plans prepared by Shepley, Rutan & Coolidge, architects, and the substructure in accordance with plans prepared by the engineers. The amount of this contract is $182,659.50. The work was begun on August 30.

The excavation for the foundations was quite difficult, as it was necessary, in order to obtain a suitable foundation for the structure and the pumping engines, to excavate to depths of from 14 to 24 feet below the surface, and much of the material excavated consisted of boulders and rock dumped upon the site of the station when Chestnut Hill Reservoir was built. Many of the stones were large, and had to be handled with power derricks.

The foundation walls of the building and chimney and the inlet conduit, pump wells and engine foundations are to be built of concrete masonry, of which about 5,200 cubic yards will be required. The placing of this concrete was commenced on October 20, and at the close of the year 3,500 cubic yards had been put in place.

The work completed included the foundation walls of the engine room and the inlet conduit and pump wells; and that partly constructed included portions of other walls of the building and some of the piers for the columns in the boiler room and coal house. On December 27, the contractor began to set the granite base courses of the superstructure of the engine room.

Work upon the three 35,000,000-gallon engines, for which a contract was made with the Holly Manufacturing Company on October 20, 1897, has not progressed as rapidly as was expected. The company has experienced difficulty in making satisfactory castings, and after considerable delay has arranged to have the large castings made by the Lorain Foundry Company of Lorain, O., and the West Point Foundry Company of Cold Spring, N. Y. Steel forgings for all of the engines have been made by the Bethlehem Iron Works, and one set of the forgings is now being finished at the shops of the contractor.

Eight sluice gates for this station are being made by the Atlantic Works of East Boston, under a contract dated September 10, 1898. Castings for these gates have been made and the shop work is now nearly all done.

NORTHERN HIGH-SERVICE PUMPING STATION.

On December 9, 1897, 4 acres of land lying between Spot Pond and Woodland Road, near the old pumping station of the city of Malden, were purchased from Arthur N. McGeoch, as a site for a pumping station for the northern high-service district.

Plans for the superstructure of the pumping station have been prepared by Shepley, Rutan & Coolidge, architects, and for the substructure by the engineers.

Proposals for building the station were received on December 29, 1898, the lowest bid amounting to $108,480. The contract had not been awarded at the end of the year.

The contract provides that the building shall be finished on or before December 15, 1899, except for such portions as necessarily have to be deferred until after the installation of the machinery.

On September 20, 1898, a contract was made with the Holly Manufacturing Company for furnishing and erecting at this station a vertical triple-expansion pumping engine, having a capacity of 20,000,000 gallons in twenty-four hours. The amount of this contract is $62,500. The only work done under it has been the preparation of drawings. By the terms of the contract the engine is to be erected on or before January 20, 1900.

In addition to this new engine, it is proposed to move to this station one of the pumping engines in the abandoned Mystic pumping station.

ENGINEERING.

The following are the principal items of work upon which the engineering force of the distribution department has been engaged during the year: —

Plans and estimates of material received and delivered in connection with 9 contracts for pipes and special castings, surveys, plans and superintendence of work in connection with 8 contracts for pipe-laying; surveys, detail plans and superintendence of construction at the northern high-service reservoir in the Middlesex Fells; superintendence of construction at the southern high-service pumping station; preparation of plans and superintendence of construction at the low-service pumping station at Chestnut Hill; topographical plan of site and preparation of plans for the northern high-service pumping station at Spot Pond; plans, studies and estimates for the improvement of Spot Pond, including surveys and plan of watershed at the northerly end of the pond. In order to properly mark the corners of the land belonging to the Board in the vicinity of the pond, 91 granite monuments and 16 iron rods have been set at the corners of the property.

Surveys and plans on a scale of 40 feet to an inch have been made of the 30-inch and 24-inch mains of the Mystic works in Medford and Somerville, taken from the city of Boston. Plans and specifications have been prepared for steam pipe and covering of same, for hydraulic lift valves and check valves, for mechanical stoker, for sluice gates for northern high-service reservoir and the high and low service pumping stations; and the construction of all work of this character has been inspected at the shops.

Investigations have been made to determine the capacity and cost of operation of the pumping plants at Medford, Somerville, Malden and Chelsea; and arrangements have been made for the use of these stations for supplying the northern high-service district until the the new station at Spot Pond shall be ready for use.

The pipe lines not previously tested have been tested under pressures of from 70 to 150 pounds per square inch, and the amount of leakage has been measured.

OFFICE FORCE.

Reuben Shirreffs, *Principal Office Assistant;* **John N. Ferguson**, *Office Assistant.*

Mr. Shirreffs has continued at the head of the designing and drafting force, and has been engaged with his force upon the great variety of work done in a drafting office. Work has been continued through a large portion of the year upon the design of the Wachusett Dam and of the power plant which it is proposed to install at the dam. Considerable work has also been done in connection with the design of the North Dike of the Wachusett Reservoir; the sewerage works for the town of Clinton, and the southern high-service, low-service and northern high-service pumping stations; record drawings have been made of several structures connected with the Wachusett Aqueduct; and record plans have been made of the land belonging to the Commonwealth at the Sudbury Reservoir.

Mr. Ferguson has continued in charge of the miscellaneous work of the office, such as procuring supplies, making blue prints, filing plans and records received from outside offices, and has also made many investigations and computations.

ACCIDENTS.

But one fatal accident has occurred during the year in connection with the works. On August 13 an Italian laborer employed by T. W. Kinser & Sons at the northern high-service reservoir was instantly killed by the falling of a box filled with earth while it was being hoisted from the trench.

MAINTENANCE.

As this is the first report covering the maintenance and operation of the Metropolitan Water Works, I will give first a statement of the works which have been maintained and operated during the whole or a part of the year: —

1. The Wachusett Aqueduct, 12 miles in length, which conveys water from the Nashua River to the Sudbury Reservoir.

2. The reservoirs of the Sudbury system, all of which were taken in a completed condition from the city of Boston, except the

Sudbury Reservoir, which was completed by the Metropolitan Water Board. The names and capacities of these reservoirs are as follows: —

NAME.	Capacity in Gallons.
Sudbury Reservoir,	7,253,500,000
Framingham Reservoir No. 1,	287,500,000
Framingham Reservoir No. 2,	529,900,000
Framingham Reservoir No. 3,	1,183,500,000
Ashland Reservoir,	1,416,400,000
Hopkinton Reservoir,	1,520,900,000
Whitehall Reservoir,	1,256,900,000
Farm Pond,	167,500,000
Total,	13,616,100,000

3. The Sudbury Aqueduct, taken from the city of Boston, extending from Framingham Dam No. 1 to Chestnut Hill Reservoir, a distance of 17.39 miles. In addition to this aqueduct there are two 48-inch pipe lines extending from Framingham Dam No. 3 to the head of the aqueduct, so that a full supply of water can be taken from this dam to the aqueduct.

4. The reservoirs of the Cochituate system, taken from the city of Boston, which are as follows: —

NAME.	Capacity in Gallons.
Lake Cochituate,	2,011,200,000
Dudley Pond,	231,200,000
Total,	2,242,400,000

5. The Pegan filters for filtering the water of Pegan Brook, Natick, taken from the city of Boston.

6. The Cochituate Aqueduct, taken from the city of Boston, extending from Lake Cochituate to Chestnut Hill Reservoir, a distance of 13.78 miles.

7. Chestnut Hill Reservoir, a distributing reservoir in the southern part of the Metropolitan Water District, taken from the city of Boston.

8. Chestnut Hill pumping station, taken from the city of Boston and enlarged by the Metropolitan Water Board.

9. The main pipe systems, constructed by the Metropolitan Water Board for conveying water from Chestnut Hill Reservoir to the various cities and towns in the Metropolitan Water District.

10. Spot Pond, the distributing reservoir in the northern part of the Metropolitan Water District, taken from the cities of Malden and Medford and the town of Melrose.

11. A small pumping station at Spot Pond, taken from the town of Melrose.

12. Mystic Lake and the aqueduct, pumping station and distributing reservoir of the Mystic Water Works, taken from the city of Boston.

CITIES AND TOWNS SUPPLIED IN 1898.

The following is a list of the cities and towns which were supplied with water from the Metropolitan Works during the whole or a portion of 1898, with the date when the water was first supplied from these works: —

Boston,	January 1.	Somerville,	January 1.
Chelsea,	January 1.	Belmont,	November 30.
Everett,	January 1.	Melrose,	January 1.
Malden,	January 21.	Revere,	February 9.
Medford,	March 12.	Watertown,	November 30.
Quincy,	December 31.	Winthrop,	February 9.

ORGANIZATION OF MAINTENANCE FORCE.

The maintenance force was organized and began its work on January 1, 1898, and the organization was not materially changed throughout the year. As already stated, the work of maintenance in the different departments was placed under the charge of the department engineers, who, however, devoted only a part of their time to this work; other engineers in the departments also devoted a part of their time to the maintenance of the works, but only those devoting their whole time are included in the following list. The organization at the end of the year was as follows: —

Dam and aqueduct department:—		
Temporary dam,	2	
Wachusett Aqueduct, including the open channel and ditches leading to it,	9	
Total, dam and aqueduct department,	—	11
Sudbury department:—		
Office at South Framingham,	3	
Sudbury Reservoir,	6	
Framingham reservoirs Nos. 1, 2 and 3,	7	
(The force at the Framingham reservoirs not only attends to the work at these reservoirs, but also does work in other parts of the watershed, and assists in cleaning aqueducts.)		
Ashland, Hopkinton and Whitehall reservoirs and Farm Pond,	4	
Lake Cochituate,	3	
Pegan filters at Lake Cochituate,	3	
Sanitary inspection of Sudbury and Cochituate watersheds,	2	
Sudbury and Cochituate aqueducts,	8	
Chestnut Hill Reservoir and grounds,	10	
Office 3 Mt. Vernon Street:—		
Engineering assistant,	1	
Biological force,	3	
Total, Sudbury department,	—	50
Distribution department:—		
Office 3 Mt. Vernon Street:—		
Superintendent of pumping stations,	1	
Assistant superintendent (pipe lines and reservoirs),	1	
Chestnut Hill pumping station,	24	
Melrose pumping station,	2	
Pipe lines and reservoirs,	32	
Total, distribution department,	—	60
Total, maintenance force,		121

RAINFALL AND YIELD.

The rainfall during the year has been very abundant, and has been so distributed as to produce an unusually large flow in the streams during the summer months.

A comparison of the records of 1898 with the average of a series of years and with a very dry year is as follows, the measurements upon the Sudbury watershed being used as a basis for comparisons: —

	1898.	Average Year.	Dry Year (1883).	Per Cent. in 1898 in Excess of —	
				Average Year.	Dry Year.
Rainfall (in inches), . . .	55.88	46.19	32.78	21	70
Rainfall collected (in inches), .	30.459	22.567	11.188	35	172
Yield of watershed (gallons per day per square mile), . .	1,450,000	1,074,000	533,000	35	172
Yield of watershed in driest six months (gallons per day per square mile), ...	777,000	465,000	145,000	67	436

Additional statistics relating to rainfall and yield of watersheds may be found in Appendix No. 3, tables 1 to 10.

STORAGE RESERVOIRS.

At the beginning of the year the Sudbury Reservoir was in condition to hold only a small quantity of water, but the other reservoirs contained an ample supply for the whole of the Metropolitan Water District.

In March water was let into the Sudbury Reservoir from the Nashua River, and early in April all of the reservoirs were practically full, providing a quantity of water in store far in excess of any previous year.

Owing to the large flow in the streams, it would have been possible to keep all of the reservoirs nearly full during the summer and autumn, had it not been necessary to draw the Sudbury Reservoir down in order to complete certain work already described in this report.

The following table gives the quantity of water stored in the storage reservoirs at the beginning of each month. The second column gives the total in the reservoirs from which the supply is usually taken, the third column the storage in the other reservoirs which are drawn from only in cases of emergency, and the last column the total storage in all reservoirs.

Quantity of Water stored at the Beginning of Each Month.

DATE.	In Sudbury Reservoir and Framingham Reservoir No. 3 (Gallons).	In All Other Storage Reservoirs (Gallons).	Total (Gallons).
January 1, 1898,	3,004,600,000	5,618,000,000	8,622,600,000
February 1,	4,019,300,000	6,406,300,000	10,425,600,000
March 1,	3,144,100,000	6,923,900,000	10,068,000,000
April 1,	6,921,700,000	6,816,500,000	13,738,200,000
May 1,	7,793,000,000	7,026,100,000	14,819,100,000
June 1,	8,015,100,000	7,284,200,000	15,299,300,000
July 1,	7,491,400,000	7,315,000,000	14,806,400,000
August 1,	5,956,500,000	7,318,000,000	13,274,500,000
September 1,	4,331,200,000	7,227,100,000	11,558,300,000
October 1,	4,144,400,000	6,918,600,000	11,063,000,000
November 1,	3,752,600,000	6,997,000,000	10,749,600,000
December 1,	3,830,700,000	6,849,800,000	10,680,500,000
January 1, 1899,	5,644,100,000	6,543,200,000	12,187,300,000

NOTE. — The storage in Dudley Pond is not included in this table.

Table No. 11 in Appendix No. 3 gives the elevation of water surfaces of reservoirs above Boston city base at the beginning of each month.

SOURCES FROM WHICH WATER HAS BEEN TAKEN.

The water for supplying Boston and the greater portion of the Metropolitan Water District was, until April 20, taken mainly from Framingham reservoirs Nos. 1 and 2, and for the remainder of the year, after the water in the Sudbury Reservoir and Framingham Reservoir No. 3 had been improved by the introduction of water from the Nashua River, was taken mainly from these reservoirs. A small part of the supply was furnished from Lake Cochituate early in the year and again in September and October.

Spot Pond, which derives a part of its supply from its own watershed and a part by pumping from the main supply, was necessarily the source from which water was taken for Melrose; and, as it is used as a distributing reservoir, other towns and cities in the northern part of the district occasionally received water drawn from this pond.

The city of Malden has pumped a small quantity of water from local sources, and the city of Medford has pumped or drawn by gravity a larger amount. The towns of Revere and Winthrop could not be supplied wholly from the Metropolitan Water Works, and the remainder of the water was necessarily taken from the sources owned by the Revere Water Company.

The city of Quincy and the towns of Watertown and Belmont could not be furnished with water from the Metropolitan Works until late in the year, and consequently were obliged to take water from local sources, but abandoned these sources as soon as a full supply from the Metropolitan Works was available.

A detailed statement of the sources from which the main supply was taken and of the quantities of water supplied from local sources may be found in Appendix No. 3, tables Nos. 12 and 13.

AQUEDUCTS.

The ordinary work of maintenance, such as mowing the grass, clearing the culverts, repairing fences and painting iron work has been performed, and the aqueducts have remained in good condition throughout the year.

The Wachusett Aqueduct has been in use 197 days, since March 7, when the water was first turned through it. The quantity of water run through this aqueduct since that time has averaged 49,230,000 gallons per day. The largest daily flow was 130,400,000 gallons. Careful gagings have been made of the flow through this aqueduct with depth up to 4 feet, and it has been found that the flow is about 3 per cent. greater at the depths for which the flow has been determined than the flow based upon a formula derived from careful experiments in the Sudbury Aqueduct.

The Sudbury Aqueduct has been in use 354 days during the year, and has conveyed to Chestnut Hill Reservoir a much larger quantity of water than in previous years. As has already been stated, the capacity of the Sudbury Aqueduct was limited by the capacity of two 48-inch pipes laid across the valley of Rosemary Brook until November 17, when a third pipe, 61 inches in diameter, was laid and ready for use. This pipe increased the capacity of the aqueduct to an extent not yet fully determined, but to not less than 105,000,000 gallons per day.

At the beginning of the year there was a railroad track in the Beacon Street tunnel, which had been built several years before to facilitate lining a portion of the tunnel with concrete. As this offered considerable resistance to the passage of a large quantity of water, it was removed in April, May and June. The consumption of water was then so large in proportion to the capacity of the aqueduct that the flow could not be shut off for more than a day at a time to do this work, and after being shut off it took quite a long time to restore Chestnut Hill Reservoir to its normal level. This caused the work to extend over a long period, although the whole of the track, a length of 4,020 feet, was removed in six days' working time.

The aqueduct was cleaned once during the year; the upper sections were cleaned on the days when the flow was stopped in order to remove the track, and the flow was stopped on two additional days to complete the cleaning, which was finished on July 19. A large quantity of sponge was found in places, principally in the tunnels where unlined; there was also a considerable quantity of a black deposit along the whole length of the aqueduct.

At the Waban Bridge the aqueduct leaked considerably during cold weather, as in preceding years; there was also some leakage through the side walls at the east end of the Charles River bridge during the warmer months. These leaks were caused by the expansion and contraction of the masonry with the changes in temperature. The leak at the Charles River bridge was repaired in June, but in a few days started again. It has not been feasible during the past year to make any thorough repairs, on account of the necessity for keeping the aqueduct almost constantly in use.

The increased quantity of water to be carried by the aqueduct made it necessary to construct a new set of screens in the Farm Pond gate-house.

The average flow through the aqueduct to Chestnut Hill Reservoir has been 70,361,000 gallons per day, and the maximum flow 85,600,000 gallons.

The Cochituate Aqueduct has been in use 143 days during the year, and has been shut off for the remainder of the time, on account of the inferior quality of the water in Lake Cochituate. The aqueduct was cleaned once, between March 28 and 31. The interior was found to be coated with a black deposit and some sponge, as is usually the case.

The average flow through the aqueduct to Chestnut Hill Reservoir has been 4,555,000 gallons per day, and the maximum flow 16,400,000 gallons.

Appendix No. 3, Table No. 14, contains detailed information with regard to the flow through the aqueducts.

PUMPING STATIONS.

The pumping stations operated during the year have been the Chestnut Hill high-service pumping station, which has been used both for the high service and for pumping water to the portion of the Metropolitan Water District north of the Charles River, and the Melrose pumping station on the shore of Spot Pond. The operation of the Mystic Pumping station was discontinued on the first day of the year, but it was kept in condition for use for several months. Arrangements were made with the authorities at Chelsea for pumping at their station a part of the water used in Revere and Winthrop.

Chestnut Hill High-service Pumping Station.

The machinery at this station consists of two compound horizontal fly-wheel engines (Nos. 1 and 2), each having a nominal capacity of 8,000,000 gallons per day, built by the Holly Manufacturing Company in 1887; a vertical triple-expansion fly-wheel engine (No. 3), having a nominal capacity of 20,000,000 gallons per day, built by the Quintard Iron Works in 1895 from designs by E. D. Leavitt; and a vertical triple-expansion fly-wheel engine (No. 4), having a nominal capacity of 30,000,000 gallons per day, designed and built by the E. P. Allis Company. This engine is not yet entirely completed, but has been operated.

Steam for engines Nos. 1 and 2 is supplied at 80 pounds pressure by two horizontal tubular boilers built by George Miles in 1887, and for engines Nos. 3 and 4 at 185 pounds pressure by two Belpaire boilers, one built by the Atlantic Works in 1895 and the other by the Lake Erie Boiler Works in 1898.

The following are the principal dimensions of the engines and boilers: —

	Engines Nos. 1 and 2.	Engine No. 3.	Engine No. 4.
Diameters of steam cylinders (inches), . .	21 42	13.7 24.375 39	30 56 87
Stroke of pistons (inches), ...	36	72	66
Diameter of pump plungers (inches), . .	25	17.5	42
Stroke of pump plungers (inches), . . .	36	48	66
Normal speed (revolutions per minute), . .	18.5	50	18

	Boilers Nos. 1 and 2.	Boiler No. 3.	Boiler No. 4.
Diameter (feet and inches), ...	6-6	7-6	7-6
Length (feet and inches), ...	18-5	34-4	34-4
Number of 3-inch tubes, ...	151	201	201
Heating surface (square feet), . . .	2,171	3,000	3,000

Engines Nos. 1 and 3, although designed for high-service engines, have been used to pump to the low-service district north of Charles River and to Spot Pond. Engine No. 3 has been used almost continuously to pump for the southern high-service, including the high-service district of Boston during the whole year, Watertown and Belmont after November 30 and Quincy the last day of the year.

The following are statistics relating to operations at this station: —

	High Service.	Low Service.	Total.
Total quantity pumped (gallons),	6,441,580,000	6,796,890,000	13,238,470,000
Total coal used (pounds), . .	5,941,002	3,977,254	9,918,256
Gallons pumped per pound of coal, ...	1,085	1,709	1,335
Daily average quantity pumped (gallons), ...	17,648,000	18,622,000	36,270,000
Cost of pumping: —			
Labor, ...	$10,070 07	$12,635 95	$22,706 02
Fuel, ...	9,714 18	6,476 13	16,190 31
Repairs, ...	535 76	1,526 35	2,062 11
Oil, waste and packing, . .	539 12	179 71	718 83
Small supplies, ...	423 41	406 80	830 21
Total for station, . . .	$21,282 54	$21,224 94	$42,507 48
Cost per million gallons pumped to reservoir, ...	$3 304	$3 123	$3 2110
Cost per million gallons raised one foot high, ...	026	075	0387

It is worthy of note that the transfer by which the work formerly done at the Mystic pumping station is now done at the Chestnut Hill pumping station has reduced the cost of pumping more than $15,000 below the cost in 1897, notwithstanding the additional cities and towns supplied and the yearly increase in water consumption, which made the total quantity of water pumped 35 per cent. greater in 1898 than in 1897. The average cost per million gallons of water pumped at both stations in 1897 was $5.89, while in 1898 the cost of pumping at the Chestnut Hill station was $3.21, making a reduction in cost of 46 per cent.

As engines Nos. 1 and 2 have been operated against a very much lower head than that for which they were designed, the duty per 100 pounds of coal has been less than during previous years. The duty of Engine No. 3 was reduced in March and April on account of the repairs on the economizer, and during the latter part of the year on account of leaks in the reheaters, which cannot be repaired until Engine No. 4 is in condition for regular service. Work in connection with the installation of the new engine and boiler has also tended to prevent the attainment of the most economical results.

As a portion of the brick setting of the Green economizer was of necessity taken down for the purpose of getting the new Belpaire boiler into the boiler room, and as the setting was badly cracked, the opportunity was taken to replace it with a sectional magnesia-lined steel covering, made so as to be easily taken down for the purpose of cleaning or repairing the economizer. This covering was furnished by the Fuel Economizer Company of Matteawan, N. Y., at a cost of $400.

On April 26 a cast-iron feed-water heater in front of the furnace of Boiler No. 1 exploded, completely demolishing the boiler setting and seriously burning a man employed by the H. W. Johns Company.

Coal has been purchased for use at the station as follows:—

Sturtevant, Norton & Co., ...	818.78 tons at	$3 80 per ton.
Metropolitan Coal Company, ...	862.32 tons at	3 69 "
John Morrison, ...	1200.00 tons at	3 33 "
John Morrison, ...	*3000.00 tons at	3 53 "

Mystic Pumping Station.

No water was pumped at this station after January 1. Until May 28 a fire was kept under one of the boilers to keep the building warm, and one man was constantly on duty to keep the machinery in order in case the necessity arose for its use. During the summer all pipes were disconnected and drained and the building has since been closed.

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* 1,160 tons of this coal have been delivered.

Melrose Pumping Station.

This station was taken from the town of Melrose on January 1, 1898, under the provisions of the Metropolitan Water Act, and has been operated solely for the supply of that town during the year. The machinery at the station consists of one compound duplex pump built by the Knowles Pump Works, having 8-inch and 16-inch steam cylinders, and 12-inch water plungers with a stroke of 18 inches. The nominal capacity of the pump is 2,000,000 gallons in twenty-four hours, and the actual capacity is about 25 per cent. greater.

The following are statistics relating to operations at this station: —

Daily average quantity of water pumped (gallons),	1,008,000
Daily average quantity of coal consumed (pounds),	2,109
Gallons pumped per pound of coal,	478
Cost of pumping: —	
Labor,	$1,566 58
Fuel,	1,780 00
Repairs and small supplies,	422 74
Total,	$3,769 32
Cost per million gallons pumped to reservoir,	$10 241
Cost per million gallons raised one foot high,	084

Pumping for Revere and Winthrop.

By an arrangement with the Chelsea water department a portion of the water used in Revere and Winthrop has been pumped at the Chelsea pumping station since February 9, and no water has been pumped at the Revere station of the Revere Water Company since that date. The daily average quantity supplied to Revere and Winthrop from the Chelsea station was about 425,000 gallons, and for this service the city of Chelsea was paid $2,829.70.

CONSUMPTION OF WATER.

The daily average quantity of water consumed in the cities and towns of the Metropolitan Water District supplied wholly or in part by the Metropolitan Water Works during the year 1898 was 79,274,000 gallons, equivalent to 103 gallons per inhabitant in the district supplied. Of the above quantity, 76,081,000 gallons per day were supplied by the Metropolitan Works and 3,193,000 gallons per day from local sources.

The daily average consumption of the low-service district, including that drawn from Chestnut Hill Reservoir by gravity, that drawn from the Spot Pond service, the greater part of which was pumped at the Chestnut Hill station, and a small quantity supplied from Wright's Pond in Medford, was 55,474,000 gallons.

The daily average consumption of the northern high-service district, which embraces the towns of Melrose, Revere and Winthrop and the higher portions of Somerville, Medford, Malden, Everett, Chelsea and East Boston, was 4,698,000 gallons; and that of the southern high-service, which includes the higher portions of the city of Boston and the whole of the city of Quincy and the towns of Watertown and Belmont, was 19,102,000 gallons.

Detailed statistics with regard to the operation of the several pumping stations may be found in Appendix No. 3, tables Nos. 15 to 17.

Quality of Water.

In order to determine the quality of the water supplied to the Metropolitan Water District, samples of water are collected each month from 17 points and each week from 3 points upon the works, and sent to the State Board of Health for analysis and examination. Samples of water are also collected each week from many points upon the works, and examined microscopically and for color, odor and taste, by the biological force of the Metropolitan Water Board. In addition to the weekly biological examinations, which are reported promptly and serve as a guide in the selection of the waters to be furnished to the district, many examinations are made at different places and depths in the reservoirs from which water is being drawn, which supply additional information regarding the best manner of operating the works so as to furnish the best possible quality of water at all times.

The waters supplied to the district from the main sources contained so few organisms during the year that they were free from any decided taste or odor, except for a short time in the early part of the year, when Synura derived from Lake Cochituate was present in sufficient quantity in Chestnut Hill Reservoir to impart its characteristic taste to the water. This was remedied by shutting off the supply from Lake Cochituate. There was a very abundant growth of Uroglena in the Hopkinton Reservoir, which reached a maximum of 1,400 standard units per cubic centimeter at the surface on May 24, and one of Clathrocystis in the same reservoir, which reached a maximum of 2,800 standard units at the surface on July 5. This is one of the reservoirs which was not used after April as a source of water supply.

The quality of the water supplied to most of the district in 1898 has been much better than in previous years. The main supply for the district for the first four months of the year was taken from the Sudbury works, and for the last eight months mainly from the Nashua River, in connection with the supply from that portion of the Sudbury watershed which feeds the Sudbury Reservoir and Framingham Reservoir No. 3.

A table which follows gives a comparison of the results of examinations of Boston tap water made in 1897 and 1898, also a similar comparison of examinations made in the last eight months of each year. A comparison of the last two columns shows that the water was much better in every respect in 1898 than in 1897, as it had much less of color and of the impurities found by chemical analysis; it also contained fewer organisms and less amorphous matter. The relative odor and taste could not be tabulated, but there was a decided improvement in these respects.

Comparison of Examinations of Boston Tap Water, 1897 and 1898.

	1897.	1898.	Last 8 Months of 1897.	Last 8 Months of 1898.
State Board of Health Examinations.				
Color (Nessler standard),	0.65	0.41	0.66	0.31
Total residue,	4.82	4.19	4.62	4.24
Loss on ignition,	1.84	1.60	1.79	1.54
Free ammonia,	0.0009	0.0008	0.0046	0.0005
Albuminoid ammonia, total.	0.0193	0.0152	0.0204	0.0143
Albuminoid ammonia, dissolved.	0.0177	0.0136	0.0185	0.0128
Albuminoid ammonia, suspended,	0.0016	0.0016	0.0019	0.0015
Chlorine,	0.40	0.26	0.38	0.27
Nitrogen as nitrates,	0.0137	0.0067	0.0110	0.0059
Nitrogen as nitrites,	0.0001	0.0001	0.0000	0.0001
Oxygen consumed.	0.64	0.44	0.63	0.38
Hardness,	1.8	1.4	1.6	1.5

Comparison of Examinations of Boston Tap Water, 1897 and 1898 — Concluded.

	1897.	1898.	Last 8 Months of 1897.	Last 8 Months of 1898.
Metropolitan Water Board Examinations.				
Color (platinum standard),	0.59	0.40	0.59	0.33
Total organisms,	351	230	442	246
Amorphous matter,	177	131	199	142
Bacteria,	105	96	104	90

NOTE. — Chemical analyses are in parts per 100,000, organisms and amorphous matter in standard units per cubic centimeter, and bacteria in number per cubic centimeter. The standard unit has an area of 400 square microns, and by its use the number of diatomaceæ are decreased and the number of chlorophyceæ and cyanophyceæ are very much increased, as compared with the number of organisms.

Although the above table shows a marked improvement in the quality of the water during the past year as compared with the previous year, it does not represent as good a water as the works are expected to furnish after the completion of the Wachusett Reservoir and the improvement of the watersheds.

As has already been stated, the water of Lake Cochituate has been of unsatisfactory quality for a large part of the year, owing to considerable growths of organisms, which give the water an unsatisfactory taste and odor; and for this reason very little water has been used from this source. The water of Framingham Reservoir No. 2, which is situated on the main Sudbury River, has been far inferior in quality to the water of Framingham Reservoir No. 3; so that all of the water available from No. 2 and from the reservoirs above it has been allowed to run to waste down the river since April 20.

Water stored in Spot Pond deteriorates in quality, owing to the unfavorable character of the pond as a reservoir, and at times the water supplied has been quite unsatisfactory in taste and odor. On this account, the water supplied to Melrose, which is necessarily pumped directly from the pond, and at times that supplied to other cities and towns in the northern part of the Metropolitan Water District, has not been as good as that supplied from Chestnut Hill

Reservoir. The improvement of Spot Pond and the construction of a new pumping station for the northern high-service district will remedy these troubles.

Appendix No. 3, tables Nos. 22 to 33, gives the detailed results of chemical, microscopical and bacterial examinations of water from various parts of the Metropolitan Water Works.

BIOLOGICAL LABORATORY.

The biological laboratory, originally established by the city of Boston, was located at Chestnut Hill Reservoir, and continued in operation at that place until July 25, 1898, when it was moved to No. 3 Mt. Vernon Street, Boston.

During the year 2,319 microscopical and 1,280 bacterial examinations of water were made. Of the microscopical examinations, 1,822 were of the regular weekly samples and 497 were made in connection with special investigations of the sources of supply.

In addition to the sources which were regularly examined by the city of Boston, samples have been taken weekly from Spot Pond since March 4, from the Nashua River at the head of the Wachusett Aqueduct since April 11, and from the lower end of the open channel of this aqueduct at frequent intervals since it was put in service, and weekly since October 19.

Samples for bacterial examination have been taken weekly from the terminal chamber of the Sudbury Aqueduct, from the influent and effluent gate-houses at Chestnut Hill Reservoir and from the reservoir itself, from the gate-house at the Brookline Reservoir and from a tap at Park Square, Boston; also at frequent intervals during the year from the Sudbury Reservoir and Framingham Reservoir No. 3.

From February 1 until May 1 examinations were made daily of samples from the terminal gate-house of the Sudbury Aqueduct.

In addition to the microscopical and bacterial work of the laboratory, determinations of the color, odor, taste and alkalinity of samples have been made, and the temperature of the water at the time of collection has been recorded.

The results of the work done by the biological force are given in Appendix No. 3: Table No. 29 contains the results of the microscopical examinations; Table No. 30, the results of bacterial examinations; Table No. 31, the color of the waters; Table No. 32, the determinations of the alkalinity of the waters; Table No. 33, the temperature of the waters; and Table No. 34, the temperature of the air.

SANITARY INSPECTION.

As the Sudbury and Cochituate watersheds contain a large population which renders the waters liable to contamination, a force of inspectors is employed to aid in maintaining the purity of the water. At the beginning of the year the force employed consisted of the chief inspector and two assistant inspectors, formerly employed by the city of Boston. In February the force was reorganized by the appointment of William W. Locke as sanitary inspector, and Andrew A. Porter, one of the assistants already on the force, was retained to assist him. Mr. Locke was graduated from the Massachusetts Institute of Technology in 1892, in the course of sanitary engineering, and was employed, subsequently, in the engineering department of the Massachusetts State Board of Health and as sanitary engineer in the health department of the city of Brooklyn, N. Y., so that he was well qualified by education and experience for his work.

While the work of sanitary inspection is done mainly upon the Sudbury and Cochituate watersheds, a portion of the time of the inspectors is also devoted to the inspection of the Nashua watershed.

For the purpose of keeping the records of work done, the Sudbury and Cochituate watersheds were each divided by the city of Boston into districts, and the same division into districts has been followed since the transfer of the works to the Metropolitan Water Board.

A summary of the work done in 1898 is given in the accompanying tables. The first table shows the number of premises inspected, the classification of the cases inspected and the condition of the premises at the end of the year.

The headings of this table explain themselves, except in a few instances; under the heading "Suspected" are included all cases where the positive information could not be obtained, but where it is suspected that there may be some objectionable drainage; under the heading "Premises Vacant" are included all cases which at present furnish no objectionable drainage, but which might furnish such drainage if the premises were occupied; under the heading

"Unsatisfactory" are included all cases where there may be, under the most unfavorable conditions, wash from privies or direct sink drainage, all suspected cases and all cases of manufacturing wastes entering feeders, even though there may be some attempt at previous purification.

The second table shows the improvements effected in 1898. No cases are entered as "Remedied" unless complete sewer connections have been made, or all probability of future contamination has been removed; and no cases are entered as "Partly Remedied" except where a positive improvement in the sanitary condition has been effected.

Summary of Sanitary Inspections in 1898.

DISTRICT.	Number of Premises Inspected.*	Classification of Cases inspected.										Condition at End of Year.	
		Cesspools dug before 1898.	Cesspools dug in 1898.	Direct Privy Drainage.	Indirect Privy Drainage.	Direct Sink Drainage.	Indirect Sink Drainage.	Manure Piles.	Manufacturing Wastes.	Suspected.	Premises Vacant.	Satisfactory.	Unsatisfactory.
Sudbury Watershed.													
Farm Pond,	2	1	-	-	-	-	-	1	-	-	-	2	-
Framingham Reservoir No. 3,	6	5	-	-	-	-	1	1	-	-	1	5	1
Stony Brook,	45	27	4	-	2	2	12	5	1	4	3	27	18
Angle Brook,	433	243	6	-	4	23	119	29	1	10	8	276	157
Framingham reservoirs Nos. 1 and 2, and Cold Spring Brook,	23	11	1	-	-	-	10	3	-	1	1	15	8
Eastern Sudbury,	35	14	1	-	1	-	9	5	-	-	10	25	10
Indian Brook,	42	21	-	-	2	1	22	8	-	4	3	15	27
Western Sudbury,	22	7	2	-	3	-	10	8	1	-	2	12	10
Whitehall Reservoir,	6	3	1	-	-	-	1	1	-	1	-	4	2
Cedar Swamp,	42	21	3	-	-	3	12	1	1	1	1	29	13
Cochituate Watershed.													
Snake Brook,	27	17	-	-	-	-	10	3	1	2	-	19	8
Pegan Brook,	208	151	1	-	-	-	9	12	1	2	1	191	17
Course Brook,	7	3	-	-	-	-	4	-	-	-	-	5	2
Beaver Dam Brook,	95	50	10	-	9	-	26	10	3	-	1	70	25
Totals,	993	574	29	-	21	34	245	87	9	25	31	695	298

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* Not including a large number of premises which were found on examination to be in a satisfactory sanitary condition, and likely to remain so. On some premises there are two or more cases.

Sanitary Improvements effected in 1898.

DISTRICT.	Remedied by Sewer Connection.	Otherwise remedied.	Partly remedied.	Cesspools abandoned on Account of Sewer Connections.
Sudbury Watershed.				
Farm Pond, ...	–	–	–	–
Framingham Reservoir No. 3, .	–	–	–	–
Stony Brook, ...	–	–	7	–
Angle Brook, ...	14	–	6	14
Framingham reservoirs Nos. 1 and 2 and Cold Spring Brook, . .	–	–	1	–
Eastern Sudbury, ...	–	–	1	–
Indian Brook, ...	–	–	–	–
Western Sudbury, ...	–	–	2	–
Whitehall Reservoir, ...	–	–	1	–
Cedar Swamp, ...	1	–	3	1
Cochituate Watershed.				
Snake Brook, ...	–	–	3	–
Pegan Brook, ...	36	3	3	34
Course Brook, ...	–	–	–	–
Beaver Dam Brook, ...	2	1	10	2
Totals, ...	53*	4	37	51

DISTRIBUTING RESERVOIRS.

The distributing reservoirs maintained by the Metropolitan Water Board are the Chestnut Hill Reservoir, Spot Pond and the Mystic Distributing Reservoir near Tufts College. Spot Pond is 20 feet higher than Chestnut Hill Reservoir, and the Mystic Reservoir is 3 feet higher than Spot Pond. Most of the time Spot Pond and the Mystic Reservoir are connected freely with the pipes of the northern low-service district, but either one can be shut off at any time, and the pressure regulated in the northern district by the other.

Chestnut Hill Reservoir.

The reservoir has been maintained in good condition. The effluent gate-house has been furnished with a new set of screens, and fitted with apparatus to enable one man to raise the screens for cleaning.

Spot Pond.

Water was first pumped into this pond from Chestnut Hill Reservoir on February 10, 1898. The pond was then about 8 feet below high-water mark. It was filled as rapidly as practicable with the spare pumping capacity at Chestnut Hill Reservoir, until it was nearly at high-water mark, so as to provide a sufficient quantity of water in store for the supply of the territory north of Charles River in case of accident to any of the pumps. During the remainder of the year it was kept at or near high-water mark until the middle of December, when the amount of water pumped was diminished so as to lower the level of the pond for its improvement in 1899.

One man has been employed to patrol the shores of the pond, to remove the floating leaves and rubbish, to care for the gate-house and screens and to record the height of the water in the pond.

Mystic Reservoir.

In the early part of the year, before Spot Pond was used to regulate the pressure of water in the district north of Charles River, the three watchmen formerly employed by the city of Boston were continued in service to take care of the reservoir and to make frequent reports day and night to the Chestnut Hill pumping station of the height of water in the reservoir. Since March 26 one man has, with occasional assistance, kept the gate-house and grounds in good order. At the gate-house cast-iron floor plates have been set over the screen openings, and both the inside and outside of the building has been painted. Three flights of steps on the slope of the embankment have been rebuilt, and a new concrete walk has been built around the reservoir on the top of the embankment; a fence on the easterly side of the reservoir lot has also been rebuilt.

MYSTIC WORKS.

These works, with the exception of the reservoir, have not been used since January 1, 1898, but they have been kept in condition so that they could be placed in service at any time. One man has been employed at the lake to care for the property and to regulate the height of water in the lake. At the pumping station a new gravel roof has been put on the older portion of the building, the grounds have been kept in order and new sills have been put under the barn and stable. Thirty tons of hay were cut on the grounds at the reservoir, pumping station and lake, and stored in the barn for use, and 9½ tons of rowen were cut and sold.

Pipe Lines.

The easterly 48-inch pipe line from Chestnut Hill Reservoir to the connections with the 30-inch and 24-inch mains leading from the Mystic Reservoir was first used for supplying water to the district on January 1, 1898. During the month of January an additional portion of this 48-inch line, extending as far as Malden, and the 48-inch and 42-inch branch line extending from Malden, through Everett to Chelsea, were placed in service. On February 10 the remainder of this 48-inch line was placed in service to convey water to Spot Pond. About 4 miles of the northern high-service pipe line between the Chelsea Reservoir and the pipes of the Revere Water Company have been used for supplying water to the towns of Revere and Winthrop since February 9.

A part of the southern high-service pipe line (4.91 miles in length), from the Chestnut Hill pumping station to Watertown and Belmont, was first used on November 30. On December 30 the northern high-service pipe line, extending from Somerville, through Medford, Malden and Everett to Chelsea, was placed in service; and on December 31 the pipe line (9.73 miles long) extending from the Chestnut Hill pumping station to Quincy was first used to supply water to Quincy.

In addition to these pipes, which were laid by the Metropolitan Water Board, the 30-inch wrought-iron and cement-lined and the 24-inch cast-iron pipe extending from the Mystic Distributing Reservoir to Walnut Street, which were taken from the city of Boston, have been maintained during the year. The valves on these pipes have been overhauled and repacked. Nine wooden valve boxes have been replaced by brick chambers, and five fire hydrants which were connected with the 24-inch pipe have been changed so that they are now connected with the pipes of the city of Somerville.

Electrolysis.

Evidence of strong currents of electricity from return systems of electric street railways, constantly flowing along the pipes of the distribution system and rendering them liable to injury from electrolytic action, has been presented while laying the pipes, at each time when a connection has been made between the parts of our pipe lines. This evidence presents itself in cases where the strongest currents are flowing, in the form of sparks of such brilliancy as to alarm the workmen. At one point a difference of potential of 6 volts was measured between the ends of the pipes, and a wire nail about 0.1 of an inch in diameter placed between the ends of the pipes was heated to a white heat by the current. At another point a difference of potential of from 4 to 6 volts was measured between two lines of pipes laid parallel with one another in the same street.

Voltage measurements have been made between the pipes and street railway rails at all accessible points where they cross or are near together. These measurements were made during November and December, after most of the pipes of the distribution system had been laid; and they show that at points within about a mile of the new power station of the Boston Elevated Railway Company in Cambridge, and at several other points near power stations, or where our pipes cross electric car lines, the pipes are positive to the rails with a maximum difference of potential of from 6 to 8 volts.

Where these currents of electricity leave the pipes there must be injurious electrolytic action, and measures should be taken to provide promptly a remedy which will prevent further injury. The subject has already been brought to the attention of the officials of the Boston Elevated Railway Company.

GENERAL STATEMENT.

It may not be out of place to state briefly the results which have been accomplished since the passage of the Metropolitan Water Act in 1895, and the outlook for the future.

Results Accomplished.

In 1895 the capacity in a very dry year of the works for supplying water to Boston was 48,000,000 gallons per day, exclusive of the Mystic source, which had a capacity of 7,000,000 gallons per day, but was so much polluted that sanitary authorities agreed that it should be abandoned as a source of domestic water supply.

In addition to these sources of supply, there were a number of minor sources within the Metropolitan Water District, as constituted at the end of 1898, which were capable of supplying in a very dry year 8,000,000 gallons of water, some of which was of good quality and much of it of poor quality. This made the aggregate safe capacity of the sources of supply in 1895, including both the good and the bad waters, 63,000,000 gallons per day.

The following table shows the average daily consumption of water in the Metropolitan Water District, as constituted at the end of 1898, with the addition of Swampscott, which is to be supplied with water from the Metropolitan Water Works, under the terms of a contract already made: —

Consumption of Water in the Metropolitan Water District and Swampscott, 1890–98.

YEAR.	Water Consumption (Gallons per Day).	Population.	Consumption per Inhabitant.
1890, ...	47,125,000	643,173	73.27
1891, ...	52,229,000	662,859	78.79
1892, ...	57,221,000	682,545	83.83
1893, ...	65,100,000	702,230	92.71
1894, ...	64,248,000	721,916	89.00
1895, ...	68,287,000	741,602	92.08
1896, ...	77,040,000	765,500	100.64
1897, ...	79,446,000	789,700	100.60
1898, ...	82,164,000	813,500	101.00

NOTE. — The statistics given in this table include the whole Metropolitan Water District and Swampscott, while similar statistics previously given have included only the cities and towns supplied wholly or in part with water in 1898.

The average daily consumption of water in 1895 was in excess of the safe capacity of the sources of supply at that time: and, with the greatly increased consumption in 1896 and 1897, there would have been a great deficiency of water had either of these years been dry.

The works built by the Metropolitan Water Board, resulting in the completion of the Sudbury Reservoir and of the Wachusett Aqueduct, by which water has been turned from the new source into the Sudbury Reservoir, have increased the safe capacity of the sources by at least 52,000,000 gallons per day; making the present safe capacity, exclusive of the Mystic and of the minor sources in the district, fully 100,000,000 gallons per day, which ensures an ample supply for a few years.

The total storage capacity upon the Boston Water Works in 1895 (exclusive of the Mystic) was 8,605,000,000 gallons, and the total upon the Metropolitan Water Works in 1898 was 15,855,500,000 gallons, — an increase of 84 per cent.

The quality of the water in some portions of the district has been greatly improved by the abandonment of the polluted or objectionable sources, and the quality of the main supply of the city of Boston has also been improved to a very considerable extent, as has already been shown in the detailed statements. An examination of the results before and after the introduction of the new supply shows a reduction in the amount of impurities found by chemical analysis, of color and in the number of micro-organisms, which warrants the general statement that the water now furnished is about one-third better than the former main supply of the city of Boston. When the works are completed, a still further improvement is expected.

The relation of the increase in capacity of sources and in storage which has already been accomplished to the increase to be attained by the completion of the works, is as follows: —

	Capacity of Main Sources (Gallons per Day).	Storage (Gallons).
1895, ...	48,000,000	8,605,000,000
1898, ...	100,000,000	15,858,500,000
When works are completed, ...	173,000,000	78,926,100,000

The investigations of the State Board of Health showed that there would be a large saving in furnishing water by joint action of the several cities and towns, instead of by independent action. This view has been verified during the past three years by many investigations made under the direction of the Metropolitan Water Board; and in nearly all cases where the authorities of cities and towns have investigated the question of entering the Metropolitan Water District, they have found that it would be more economical to obtain a supply from the Metropolitan Water Works than to carry on independent works, with the expenses incidental to their maintenance and development.

RELATION OF WATER CONSUMPTION TO CAPACITY OF AQUEDUCTS.

The table given on page 140 shows the very great increase in the quantity of water consumed from 1890 to 1898. During the eight years the population has increased 26 per cent., while the consumption of water has increased 74 per cent.; showing that the increase in the total consumption is due to a greater extent to the increase in the consumption per inhabitant than to the increase in the number of inhabitants within the district. The increase in the consumption from 1890 to 1898 equalled 4,380,000 gallons per day; and, if it should continue at this rate, the consumption for the next few years would be as follows: —

	Gallons.
1899,	86,544,000
1900,	90,924,000
1901,	95,304,000
1902,	99,684,000
1903,	104,064,000

There is reason to believe that, with the present tendencies, the consumption of water will increase more rapidly in the next few years than it has in the past eight; first, because the pressure in the low-service district of the city of Boston is to be increased as soon as the new pumping station at Chestnut Hill can be put in operation; and, second, because the weather conditions in 1897 and 1898 have favored an abnormally low consumption of water. The summers of both years have been unusually wet, so that it has not been necessary to sprinkle lawns; and the comparatively mild winters have diminished the quantity of water wasted to prevent service pipes from freezing.

The increase in the consumption of water due to the increased pressure and to normal weather conditions is likely to more than offset the amount of water which will be pumped from the few local sources to be retained; so that the consumption above given may be regarded as the amount to be brought through aqueducts, in addition to what the local sources will furnish.

In the report of the State Board of Health upon a Metropolitan Water Supply, it was stated that the Sudbury and Cochituate aqueducts have sufficient capacity to supply the Metropolitan Water District with water until the "average consumption becomes 100,000,000 gallons per day in excess of what local sources will furnish." Upon this basis, which is a reasonable one, the new aqueduct should be ready for service in 1902, if the consumption of water is to increase in accordance with the figures above given.

Waste and Misuse of Water.

The statistics already given with regard to the consumption of water since 1890 indicate that there is a very large quantity wasted or misused. There is a legitimate increase in the consumption of water per inhabitant from year to year, occasioned by the greater wealth of the community, which enables a greater proportion of the population to have bath-tubs, closets and other water fixtures which use water in large quantities. The amount of water used for manufacturing and mechanical purposes also increases much faster than the population, and there are other reasons for an increasing use of water per inhabitant.

There is, however, an increasing waste and misuse of water, which might be stopped to a considerable extent by the application of meters, or by other measures which may be taken to prevent waste and misuse. These matters have not received any extended attention from your engineering department, because of the demands upon the time of the engineers for planning and constructing new works, but they should receive attention.

Appended to this report are tables of contracts giving the amount of work done and other information, a statement of the cement tests made by the dam and aqueduct department, a long series of tables relating to the maintenance of the Metropolitan Water Works, tables showing the length of main pipes, and number of service-pipes, meters and fire-hydrants in the Metropolitan Water District, and a summary of statistics for 1898.

Respectfully submitted,

FREDERIC P. STEARNS,
Chief Engineer.

Boston, December 31, 1898.

APPENDIX.

APPENDIX No. 1.

CONTRACTS MADE AND PENDING DURING THE YEAR 1898.

Contract made by the City of Boston and assumed by the Metropolitan Water Board Jan. 4, 1896, relating to the Sudbury Reservoir.

1. WORK.	2. Contractor.	3. Date of Contract.	4. Date for Completion of Contract.	5. Date of Final Estimate.	6. Amount of Contract.	7. Value of Work done Dec. 31, 1898.
Section A, Sudbury Reservoir.*	Auguste Saucier, South Framingham, Mass.	1894. Aug. 27,	1894. Dec. 1,	1898. Oct. 11,	$91,290 43	$91,290 43

* Contract completed.

CONTRACTS MADE AND PENDING

Contracts made by the Metropolitan Water Board

	1. Number of Contract.	2. WORK.	3. Number of Bids.	AMOUNT OF BID. 4. Next to Lowest.	AMOUNT OF BID. 5. Lowest.	6. Contractor.
1	11*	Section K, Sudbury Reservoir.	7	$49,210 00	$45,600 00†	Blagen & Bush, Portland, Ore., and Springfield, Mass.
2	13*	Section M, Sudbury Reservoir.	9	107,675 00	105,850 00†	H. P. Nawn, Boston, Mass.
3	15	Section O, Sudbury Reservoir.	9	151,113 00	136,040 00†	Washburn & Washburn, New York, N. Y.
4	16*	Section P, Sudbury Reservoir.	10	79,110 00	77,645 00†	H. P. Nawn, Boston, Mass.
5	17	Section Q, Sudbury Reservoir.	14	123,690 00†	115,010 00	Washburn & Washburn, New York, N. Y.
6	69*	Taking from cars, hauling and distributing 48-inch pipes for line from Framingham Dam No. 3 to the Sudbury Aqueduct.	1	-	1.20 per ton.	L. F. Childs, Framingham, Mass.
7	75*	Laying 48-inch water pipes from Framingham Dam No. 3 to the Sudbury Aqueduct.	6	14,603 50	12,902 90†	H. P. Nawn, Boston, Mass.
8	110*	Taking from cars, hauling and distributing 61-inch pipes and special castings along the line of the Rosemary Siphon on the Sudbury Aqueduct in Wellesley.	1	-	1.15 per ton.	T. Tighe & Sons, Somerville, Mass.
9	112*	Laying 61-inch water pipes in Wellesley, connecting the Rosemary Siphon chambers of the Sudbury Aqueduct.	7	4,814 10†	4,353 90	A. L. Norton & Co., Syracuse, N. Y.
10	118*	Settling reservoir for the Marlborough filter-beds.	2	2,282 75	2,081 00†	Mignault & McGrain, South Framingham, Mass.
11	138	Spillway Channel, Sudbury Dam.	2	2,283 00	1,892 00†	Mignault & McGrain, South Framingham, Mass.
		Total, ...	. .	. . .	. . .	. . . .

* Contract completed. † Contract based upon this bid.

DURING THE YEAR 1898 — *Continued.*

relating to the Sudbury Department.

7. Date of Contract.	8. Date for Completion of Contract.	9. Date of Final Estimate.	10. Prices of Principal Items of Contracts made in 1898.	11. Amount of Contract.	12. Value of Work done Dec. 31, 1898.	
May 8, '96,	Dec. 1, '97,	March 5, '98,	- -	$56,167 62	$56,167 62	1
April 27, '96,	Dec. 1, '97,	Jan. 6, '98,	- -	107,879 43	107,879 43	2
April 27, '96,	Dec. 1, '97,	-	- -	140,898 34	140,898 34	3
April 27, '96,	Dec. 1, '97,	Feb. 7, '98,	- -	86,430 70	86,430 70	4
April 27, '96,	Dec. 1, '97,	-	- -	125,706 29	125,706 29	5
July 10, '97,	-	Jan. 18, '98,	- -	1,970 95	1,970 95	6
Sept. 3, '97,	Nov. 15, '97,	Jan. 15, '98,	- -	15,269 27	15,269 27	7
April 20, '98,	-	Nov. 8, '98,	Taking from cars, hauling and distributing, $1.15 per ton.	930 33	930 33	8
May 25, '98,	Dec. 1, '98,	Nov. 21, '98,	Laying 61-inch pipe, $2.49 per lin. ft.	4,986 63	4,986 63	9
July 23, '98,	Oct. 1, '98,	Nov. 23, '98,	Earth excavation, $0.18 per cu. yd.; split-stone masonry in mortar, $8.50 per cu. yd.; rubble-stone masonry in mortar, $5.50 per cu. yd.; cement-concrete masonry, $5.00 per cu. yd.	2,380 45	2,380 45	10
Oct. 29, '98,	Dec. 10, '98,	-	Split-stone masonry in mortar, $13.00 per cu. yd.; rubble-stone masonry in mortar, $7.00 per cu. yd.; pointed coping, $3.50 per lin. ft.	1,892 00	1,400 00	11
. . .	. . .	. . .	. . . .	$544,512 01	$544,020 01	

CONTRACTS MADE AND PENDING

Contracts made by the Metropolitan Water Board

	1. Number of Contract.	2. WORK.	3. Number of Bids.	Amount of Bid. 4. Next to Lowest.	Amount of Bid. 5. Lowest.	6. Contractor.
1	81*	Section 2, Wachusett Reservoir, excavating 55,000 cu. yds. soil.	13	$9,845 00	$9,281 25†	Neill McBride, Brighton, Mass.
2	103*	Part of section 4, Wachusett Reservoir, excavating 18,600 cu. yds. earth and building a dike.	11	3,329 40	3,324 75†	Neill Devine & Co., Clinton, Mass.
3	106*	Part of sections 4 and 6, Wachusett Reservoir, excavating 24,700 cu. yds. earth and grading a portion of a railway.	18	3,705 00	3,458 00†	Moulton & O'Mahoney, Boston, Mass.
4	107	Section 3, Wachusett Reservoir, excavating soil and building a road.	21	42,499 38	40,621 00†	T. H. Riddle & Co., New York, N. Y.
5	116*	Part of Section 4, Wachusett Reservoir, excavating 31,900 cu. yds. earth and building a road.	13	5,603 25	5,364 00†	Newell & Snowling Construction Co., Uxbridge, Mass.
6	125	Excavation for easterly portion, North Dike, 290,000 cu. yds. earth excavation.	9	49,975 00	43,812 50†	Joseph D. Gennaro, Boston, Mass.
		Total for Wachusett Reservoir, . .	. .	. . .	. . .	. . . . .

Contracts made by the Metropolitan Water Board

	1. Number of Contract.	2. WORK.	3. Number of Bids.	Amount of Bid. 4. Next to Lowest.	Amount of Bid. 5. Lowest.	6. Contractor.
7	2*	Section 2, Wachusett Aqueduct, 4,300 lin. ft. in tunnel.	19	$133,388 00	$122,398 00†	E. D. Smith & Co., Philadelphia, Pa.
8	3*	Section 3, Wachusett Aqueduct, 6,017 lin. ft. in tunnel, 1,000 lin. ft. in open trench.	18	265,082 50	248,428 00†	E. D. Smith & Co., Philadelphia, Pa.
9	21*	Section 6, Wachusett Aqueduct, 6,400 lin. ft. masonry aqueduct.	16	124,325 50	123,775 90†	S. Casparis, Columbus, Ohio.
10	37	Section 11, Wachusett Aqueduct, open channel, 15,800 feet in length, with two small masonry dams and several stone arch road bridges.	21	89,470 00†	86,960 00	Moulton & O'Mahoney, Boston, Mass.
11	96*	Superstructure over gaging manhole, Wachusett Aqueduct.	3	2,348 00	1,584 00†	New England Granite Works, Concord, N. H.
12	127	Section 1, Clinton Sewerage System, Filter-beds.	12	19,022 20†	18,709 00	Newell & Snowling Construction Co., Uxbridge, Mass.

* Contract completed. † Contract based upon this bid.

DURING THE YEAR 1898 — *Continued.*

relating to the Wachusett Reservoir.

7. Date of Contract.	8. Date for Completion of Contract.	9. Date of Final Estimate.	10. Prices of Principal Items of Contracts made in 1898.	11. Amount of Contract.	12. Value of Work done Dec. 31, 1898.	
Sept. 15, '97,	Dec. 1, '97,	Jan. 15, '98,	- -	$12,067 11	$12,067 11	1
Mar. 25, '98,	May 1, '98,	May 23, '98,	Earth excavation, $0.17¾ per cu. yd.	3,450 11	3,450 11	2
Apr. 5, '98,	June 10, '98,	Nov. 20, '98,	Earth excavation, $0.14 per cu. yd.	9,884 56	9,884 56	3
May 10, '98,	Oct. 1, '98,	-	Earth excavation, $0.18 per cu. yd.; rock excavation, $1.00 per cu. yd; slope paving, $0.80 per cu. yd.; riprap, $1.50 per cu. yd.	52,456 96	52,456 96	4
June 22, '98,	Aug. 15, '98,	Oct. 25, '98,	Earth excavation, $0.16 per cu. yd.	6,052 22	6,052 22	5
Aug. 11, '98,	May 20, '99,	-	Earth excavation, $0.14¾ per cu. yd.	43,812 50	20,230 00	6
. . .	. . .	. . .	. . . .	$127,723 46	$104,140 96	

relating to the Dam and Aqueduct Department.

7.	8.	9.	10.	11.	12.	
Feb. 14, '96,	Dec. 1, '97,	Jan. 19, '98,	- -	$128,720 11	$128,720 11	7
Feb. 14, '96,	Dec. 1, '97,	Mar. 24, '98,	- -	242,601 06	242,601 06	8
May 9, '96,	Nov. 15, '97,	Jan. 28, '98,	- -	148,753 49	148,753 49	9
Sept. 22, '96,	Dec. 1, '97,	-	- -	168,000 00	168,000 00	10
Nov. 8, '97,	-	Jan. 12, '98,	- -	1,584 00	1,584 00	11
Sept. 9, '98,	May 15, '99,	-	Earth excavation $0.19 per cu. yd.; brick masonry, $15.00 per cu. yd.; furnishing and laying vitrified pipe as follows: 24-inch carriers $1.00 per lin. ft., 18-inch carriers $0.60 per lin. ft., 8-inch underdrains $0.55 per lin. ft., 6-inch underdrains, $0.53 per lin. ft.	19,022 20	18,368 46	12

Contracts made and pending

Contracts made by the Metropolitan Water Board

	1. Number of Contract.	2. WORK.	3. Number of Bids.	Amount of Bid. 4. Next to Lowest.	5. Lowest.	6. Contractor.
1	128	Section 2, Clinton Sewerage System, intercepting sewer, reservoir, pumping station foundations and force main.	12	$29,861 30	$29,389 50*	Owen Cunningham & Son, Somerville, Mass.
2	135†	Pipe bridge over the Nashua River, Clinton, Mass.	6	1,925 00	1,875 00*	New Jersey Steel and Iron Co., Trenton, N. J.
		Total for Dam and Aqueduct Dept., .	. .	. . .	. . .	. . . . . .

Contracts made by the Metropolitan Water Board

Water Pipes.

3	54†	5,687 tons cast-iron water pipes; 3,020 tons 48-inch, 1,587 tons 36-inch, 1,080 tons 20-inch.	3 Bids rejected.	$18.94 per ton.	$18.70 per ton.	McNeal Pipe & Foundry Co., Burlington, N. J.
4	82†	161 tons special castings, .	2	Lot No. 1, $37.00 per ton; Lot No.2, $57.00 per ton.	Lot No. 1, $34.40 per ton; Lot No.2, $44.20 per ton.*	McNeal Pipe & Foundry Co., Burlington, N. J.
5	102†	1,200 tons 60-inch cast-iron water pipes.	3	$18.80 per ton.	$18.00 per ton.*	McNeal Pipe & Foundry Co., Burlington, N. J.
6	105†	312 tons special castings, .	4	Item 1, $37.00 per ton; Item 2, $45.00 per ton.	Item 1, $34.00 per ton; Item 2, $57.00 per ton.*	McNeal Pipe & Foundry Co., Burlington, N. J.
7	115†	340 tons 16-inch cast-iron water pipes.	3	$17.40 per ton.	$17.00 per ton.*	Camden Iron Works, Camden, N. J.

* *Contract* based upon this bid. † Contract completed.

DURING THE YEAR 1898 — *Continued.*

relating to the Dam and Aqueduct Department — Concluded.

7. Date of Contract.	8. Date for Completion of Contract.	9. Date of Final Estimate.	10. Prices of Principal Items of Contracts made in 1898.	11. Amount of Contract.	12. Value of Work done Dec. 31, 1898.	
Sept. 8, '98,	June 15, '99,	-	Earth excavation for intercepting sewer, $0.40 per cu. yd.; earth excavation for reservoir and pumping station, $0.50 per cu. yd.; brick masonry laid in Rosendale cement mortar, $11.50 per cu. yd.; Portland cement concrete masonry, $6.50 per cu. yd.; furnishing and laying 24-inch vitrified pipe, $1.00 per lin. ft.; furnishing and laying 20-inch vitrified pipe $0.85 per lin. ft.; furnishing and laying 6-inch vitrified pipe $0.25 per lin. ft.; laying 18-inch cast-iron pipe, $0 60 per lin. ft.	$29,389 50	$11,813 12	1
Sept. 16, '98,	Nov. 1, '98,	Dec. 31, '98,	For bridge complete, $1,875,	1,875 00	1,875 00	2
. . .	. . .	. . .	. . . .	$739,945 36	$721,715 24	

relating to the Distributing System.

Water Pipes.

Mar. 4, '97,	Oct. 1, '97,	Jan. 14, '98,	- -	$102,620 86	$102,620 86	3
Aug. 30, '97,	Dec. 15, '97,	Jan. 25, '98,	- -	6,081 41	6,081 41	4
Mar. 21, '98,	Sept. 1, '98,	Nov. 17, '98,	Straight pipe, $18.00 per ton of 2,000 pounds; 450 tons to be delivered at the pipe yards, 750 tons to be delivered at Highlandville.	24,010 40	24,010 40	5
Mar. 26, '98,	July 1, '98,	Dec. 19, '98,	3-way and 4-way branches, blow-off branches without manholes, curves, reducers, caps, offset pipes and sleeves $34.00 per ton of 2,000 pounds; manhole pipes, blow-off branches with manholes, and Y branches, $57.00 per ton of 2,000 pounds; 210 tons to be delivered at the pipe yards, 25 tons to be delivered at Highlandville.	11,521 03	11,521 03	6
June 4, '98,	July 15, '98,	Aug. 18, '98,	Straight pipe, $17.00 per ton of 2,000 pounds, delivered at the pipe yards.	5,755 73	5,755 73	7

CONTRACTS MADE AND PENDING

Contracts made by the Metropolitan Water Board

Water Pipes — Concluded.

	1. Number of Contract.	2. WORK.	3. Number of Bids.	AMOUNT OF BID. 4. Next to Lowest.	AMOUNT OF BID. 5. Lowest.	6. Contractor.
1	117*	991 tons cast-iron water pipes; 449 tons 36-inch, 72 tons 30-inch, 15 tons 24-inch, 72 tons 20-inch, 150 tons 18-inch, 40 tons 16-inch, 28 tons 12-inch.	4	$17.20 per ton.	$16.60 per ton.†	Warren Foundry & Machine Co., Phillipsburg, N. J.
2	120	185 tons special castings, .	2	$37.00 per ton.	$34.00 per ton.†	McNeal Pipe & Foundry Co., Burlington, N. J.
3	121	70 tons special castings, .	2	$57.00 per ton.	$55.00 per ton.†	Camden Iron Works, Camden, N. J.
4	130*	1,065 tons 16-inch cast-iron water pipes.	4	$17.00 per ton.	$17.00 per ton.†	Warren Foundry & Machine Co., Phillipsburg, N. J.
5	131*	1,065 tons 16-inch cast-iron water pipes.	4	$17.00 per ton.	$16.78 per ton.†	McNeal Pipe & Foundry Co., Burlington, N. J.
6	140*	188 tons 12-inch cast-iron water pipes.	3	$17.50 per ton.	$17.40 per ton.†	Warren Foundry & Machine Co, Phillipsburg, N. J.
		Total for pipes, . .	. .	. . .	. . .	. . . .

Pipe-laying.

7	47*	Furnishing and laying water pipes across Charles River between Boston and Cambridge (sections 3 and 10).	2	$79,850 00	$38,992 00†	MacRitchie & Nichol, Chicago, Ill.
8	58*	Laying 12,000 lin. ft. of 48-inch and 4,300 lin. ft. of 16-inch cast-iron water pipes in Cambridge, Somerville and Medford (sections 11 and 18).	10	34,012 75	30,274 00	H. A. Hanscom & Co., West Medford, Mass.
9	71*	Laying 15,800 lin. ft. of 48-inch cast iron water pipes in Brookline and West Roxbury (portion of Section 19).	18	34,819 00	34,269 00†	E. W. Everson & Co., Providence, R. I.

* Contract completed. † Contract based upon this bid.

DURING THE YEAR 1898 — *Continued.*

relating to the Distributing System — Continued.

Water Pipes — Concluded.

7. Date of Contract.	8. Date for Completion of Contract.	9. Date of Final Estimate.	10. Prices of Principal Items of Contracts made in 1898.	11. Amount of Contract.	12. Value of Work done Dec. 31, 1898.	
July 5, '98,	Oct. 15, '98,	Dec. 22, '98,	Straight pipe, $16.60 per ton of 2,000 pounds, delivered at the pipe yards.	$16,777 90	$16,777 90	1
July 13, '98,	Dec. 1, '98,	-	3-way and 4-way branches, blow-off branches without manholes, curves, reducers, caps, offset pipes and sleeves $34.00 per ton of 2,000 pounds, delivered at the pipe yards.	6,290 00	3,842 00	2
July 13, '98,	Dec. 1, '98,	-	Manhole pipes, blow-off branches with manholes and Y branches $55.00 per ton of 2,000 pounds delivered at the pipe yards.	3,850 00	1,320 00	3
Aug. 19, '98,	Nov. 1, '98,	Dec. 22, '98,	Straight pipe, $17.00 per ton of 2,000 pounds, delivered at stations between Boston and Lynn.	18,297 23	18,297 23	4
Aug. 19, '98,	Nov. 1, '98,	Dec. 22, '98,	Straight pipe, $16.78 per ton of 2,000 pounds, delivered at stations between Boston and Lynn.	18,202 37	18,202 37	5
Nov. 7, '98,	Nov. 25, '98,	Dec. 22, '98,	Straight pipe, $17.40 per ton of 2,000 pounds, delivered at the pipe yards.	2,427 96	2,427 96	6
. . .	. . .	. . .	. . . .	$215,834 89	$210,856,89	

Pipe-laying.

7. Date of Contract.	8. Date for Completion of Contract.	9. Date of Final Estimate.	10. Prices of Principal Items of Contracts made in 1898.	11. Amount of Contract.	12. Value of Work done Dec. 31, 1898.	
Feb. 24, '97,	Oct. 1, '97,	May 16, '98,	- -	$40,507 71	$40,507 71	7
April 6, '97,	Nov. 1, '97,	Jan. 10, '98,	- -	35,503 40	35,503 40	8
Aug. 3, '97,	June 1, '98,	Sept. 16, '98,	- -	36,842 54	36,842 54	9

CONTRACTS MADE AND PENDING

Contracts made by the Metropolitan Water Board

Pipe-laying — *Continued.*

	1. Number of Contract.	2. WORK.	3. Number of Bids.	AMOUNT OF BID.		6. Contractor.
				4. Next to Lowest.	5. Lowest.	
1	77*	Laying 11,500 lin. ft. of 20-inch cast-iron water pipes in Newton and Watertown (portion of Section 24).	16	$9,040 25	$8,524 00†	S. W. Frescoln, Reading, Pa.
2	79*	Laying 16,000 lin. ft. of 24-inch cast-iron water pipes in Dorchester, Milton and Quincy (Section 21).	12	13,591 75	12,402 30†	Saucier & O'Brien, Boston, Mass.
3	86*	Laying water pipes across Malden River in Malden (portion of Section 6).	5	9,198 00	8,736 00†	Moore & Co., and Wm. H. Ward, Boston, Mass.
4	92*	Laying 2,400 lin. ft. of 48-inch cast-iron water pipes in Brighton (portion of Section 1).	9	5,347 50	4,636 50†	Malone & McHale, Mt. Auburn, Mass.
5	97*	Laying 420 lin. ft. of 48-inch and 660 lin. ft. of 20-inch cast-iron water pipes across the Mystic River in Medford.	-‡	-‡	-‡	Cheney & Trumbulls, Boston, Mass.
6	109	Laying 17,300 lin. ft. of 36-inch cast-iron water pipes in West Roxbury and Dorchester (Section 20).	11	26,717 00	23,819 00†	H. A. Hanscom & Co., West Medford, Mass.
7	111*	Laying 2,000 lin. ft. of 12-inch cast-iron water pipes in Breed's Island, Boston.	3	1,779 00	1,383 25†	H. A. Hanscom & Co., West Medford, Mass.
8	113*	Laying 1,150 lin. ft. of 20-inch cast-iron water pipes across Charles River in Newton and Watertown (portion of Section 24).	5	4,944 00†	4,048 20	E. W. Everson & Co., Providence, R.I.
9	114*	Laying 2,800 lin. ft. of 48-inch cast-iron water pipes in Brookline (portion of Section 19).	3	6,854 00	6,400 50†	Bruno & Salomone, Boston, Mass.
10	119*	Laying 4,925 lin. ft. of 16-inch and 450 lin. ft. of 12-inch cast-iron water pipes in Watertown and Belmont (Section 25).	7	2,986 75	2,594 75†	Michael Russo, Boston, Mass.
11	124*	Laying 3,060 lin. ft. of 48-inch cast-iron water pipes in Brighton (portion of Section 9).	5	5,649 70	5,628 46†	Bruno & Salomone, Boston, Mass.

* Contract completed. † Contract based upon this bid.

‡ Competitive bids were not received on this contract.

DURING THE YEAR 1898 — *Continued.*

relating to the Distributing System — Continued.

Pipe-laying — *Continued.*

7. Date of Contract.	8. Date for Completion of Contract.	9. Date of Final Estimate.	10. Prices of Principal Items of Contracts made in 1898.	11. Amount of Contract.	12. Value of Work done Dec. 31, 1898.	
Sept. 2, '97,	Dec. 1, '97,	Jan. 15, '98,	- -	$8,892 10	$8,892 10	1
Sept. 2, '97,	Dec. 1, '97,	July 23, '98,	- -	13,462 66	13,462 66	2
Oct. 5, '97,	Jan. 1, '98,	Feb. 10, '98,	- -	9,448 65	9,448 65	3
Oct. 21, '97,	Dec. 1, '97,	July 11, '98,	- -	6,867 63	6,867 63	4
Nov. 13, '97,	Jan. 1, '98,	Jan. 26, '98,	- -	2,561 65	2,561 65	5
May 11, '98,	Sept. 15, '98,	-	Laying 36-inch pipe, $0.95 per lin. ft.	30,673 90	30,673 90	6
May 11, '98,	July 1, '98,	June 4, '98,	Laying 12-inch pipe, $0.56 per lin. ft.	1,280 19	1,280 19	7
May 16, '98,	Aug. 1, '98,	Sept. 17, '98,	Laying 20-inch pipe, $1.20 per lin. ft.; laying 20-inch pipe across Charles River, $11.00 per lin. ft.	5,050 36	5,050 36	8
June 22, '98,	Sept. 1, '98,	Oct. 26, '98,	Laying 48-inch pipe, $1.85 per lin. ft.	5,788 35	5,788 35	9
July 22, '98,	Sept. 1, '98,	Oct. 17, '98,	Laying 16-inch pipe, $0.39 per lin. ft.; 12-inch pipe, $0.30 per lin. ft.	2,663 34	2,663 34	10
Aug. 11, '98,	Oct. 1, '98,	Dec. 15, '98,	Laying 48-inch pipe, $1.79 per lin. ft.	5,971 25	5,971 25	11

CONTRACTS MADE AND PENDING

Contracts made by the Metropolitan Water Board

Pipe-laying — *Concluded.*

	1. Number of Contract.	2. WORK.	3. Number of Bids.	Amount of Bid. 4. Next to Lowest.	Amount of Bid. 5. Lowest.	6. Contractor.
1	133	Laying 19,200 lin. ft. of 16-inch cast-iron water pipes in Revere, Saugus and Lynn (Section 26).	10	$11,477 00	$11,166 00*	Mirick & Wentworth, Malden, Mass.
2	134	Laying 12,200 lin. ft. of 16-inch and 2,800 lin. ft. of 12-inch cast-iron water pipes in Lynn (Section 27).	4	10,311 50	9,742 50*	O'Rourke & Nelson, Boston, Mass.
3	Agreement.†	Laying 2,300 lin. ft. of 12-inch cast-iron water pipes in Malden.	-‡	-‡	-‡	The C. H. Eglee Co., Boston, Mass.
		Total for pipe-laying, .	. .	. . .	. . .	. . . .

Miscellaneous.

4	46	Pumping engine for the Chestnut Hill high-service pumping station in Boston.	-‡	-‡	-‡	The Edward P. Allis Co., Milwaukee, Wis.
5	51†	73 water valves; 30 12-inch, 10 16-inch, 6 20-inch, 6 24-inch, 6 30-inch, 15 36-inch.	6	$12,546 00	$11,390 00*	Kennedy Valve Mfg. Co., New York, N. Y.
6	67†	54 water valves; 24 36-inch, 6 30-inch, 8 24-inch, 6 20-inch, 10 12-inch.	2	12,432 00	11,160 00*	Camden Iron Works, Camden, N. J.
7	72	3 pumping engines for the Chestnut Hill low-service pumping station in Boston.	5	195,000 00	136,500 00*	Holly Mfg. Co., Lockport, N. Y.
8	76†	90-inch Belpaire boiler for the Chestnut Hill high-service pumping station in Boston.	3	15,000 00	13,750 00*	Lake Erie Boiler Works, Buffalo, N. Y.
9	80	Addition to Chestnut Hill pumping station.	3	73,980 00	47,979 00*	C. A. Dodge & Co., Boston, Mass.
10	83†	Pipe bridge over the Mystic River in Medford (abutments).	10	3,640 00	3,390 00*	Cheney & Trumbulls, Boston, Mass.
11	84†	Pipe bridge over the Mystic River in Medford (superstructure).	5	4,087 00	3,980 00*	New Jersey Steel and Iron Co., Trenton, N. J.
12	85†	Addition to Chestnut Hill pumping station (iron work).	6 .	4,027 00	3,140 00*	Edward Kendall & Sons, Cambridgeport, Mass.
13	88†	19 water valves; 13 16-inch, 6 12-inch.	-‡	-‡	-‡	Coffin Valve Co., Boston, Mass.

* Contract based upon this bid. † Contract completed.

‡ Competitive bids were not received on this contract.

DURING THE YEAR 1898 — *Continued.*

relating to the Distributing System — Continued.

Pipe-laying — *Concluded.*

7. Date of Contract.	8. Date for Completion of Contract.	9. Date of Final Estimate.	10. Prices of Principal Items of Contracts made in 1898.	11. Amount of Contract.	12. Value of Work done Dec. 31, 1898.	
Sept. 19, '98,	Dec. 1, '98,	-	Laying 16-inch pipe, $0.53 per lin. ft.	$12,000 00	$11,400 00	1
Sept. 19, '98,	Dec. 1, '98,	-	Laying 16-inch pipe, $0.65 per lin. ft.; 12-inch pipe, $0.45 per lin. ft.	9,742 50	9,141 97	2
Dec. 5, '98,	-	Dec. 31, '98,	Laying 12-inch pipe, $0.65 per lin. ft.; rock excavation, $4.00 per cubic yard.	1,568 33	1,568 33	3
. . .	. . .	. . .	. . . .	$228,824 59	$227,624 06	

Miscellaneous.

7.	8.	9.	10.	11.	12.	
Jan. 1, '97,	July 1, '98,	-	- -	$114,000 00	$110,000 00	4
Feb. 15, '97,	Nov. 15, '97,	Feb. 16, '98,	- -	11,390 00	11,390 00	5
June 19, '97,	Nov. 6, '97,	Jan. 27, '98,	- -	17,900 00	17,900 00	6
Oct. 20, '97,	July 20, '99,	-	- -	136,500 00	19,000 00	7
Sept. 1, 97,	Mar. 15, '98,	July 21, '98,	- -	13,650 00	13,650 00	8
Sept. 21, '97,	Mar. 1, '98,	-	- -	49,037 02	48,000 00	9
Sept. 17, '97,	Dec. 15, '97,	Jan. 26, '98,	- -	3,570 28	3,570 28	10
Sept. 23, '97,	Dec. 15, '97,	May 3, '98,	- -	3,980 00	3,980 00	11
Oct. 8, '97,	Jan. 15, '98,	Apr. 13, '98,	- -	3,199 32	3,199 32	12
Oct. 2, '97,	Jan. 11, '98,	Jan. 29, '98,	- -	1,845 00	1,845 00	13

CONTRACTS MADE AND PENDING

Contracts made by the Metropolitan Water Board

Miscellaneous — *Continued.*

	1. Number of Contract.	2. WORK.	3. Number of Bids.	Amount of Bid. 4. Next to Lowest.	5. Lowest.	6. Contractor.
1	89*	Gate-house and connections at Spot Pond, Stoneham, Mass.	4	$26,475 00	$19,982 50†	The C. H. Eglee Co., Boston, Mass.
2	93*	Pipe bridge over the Boston & Albany Railroad at St. James Street, Newton.	5	1,514 00	1,500 00†	Boston Bridge Works, Boston, Mass.
3	94*	Steel work for covering valve chambers.	8	1,590 00	1,496 00†	New England Structural Co., East Everett, Mass.
4	95*	Building and erecting hand travelling crane, Chestnut Hill pumping station.	6	1,970 00†	1,550 00‡	Brown Hoisting and Conveying Machine Co., Cleveland, Ohio.
5	99*	Pipe bridge over the Boston & Maine Railroad at College Avenue, Medford.	7	8,190 00	3,097 00†	Pittsburg Bridge Co., Pittsburg, Pa.
6	100	Steam piping for the Allis No. 4 engine, Chestnut Hill high-service pumping station, Boston.	6	1,745 00	1,569 00†	The William H. Gallison Co., Boston, Mass.
7	101*	Cast-iron frames and covers,	9	1,032 00	963 20†	Davis & Farnum Manufacturing Co., Waltham, Mass.
8	104*	7 36-inch hydraulic lift valves; 1 48-inch and 1 36-inch check valve.	4	8,700 00	8,400 00†	Camden Iron Works, Camden, N. J.
9	108*	High-service reservoir and gate chamber in the Middlesex Fells in Stoneham, Mass. (Work discontinued and remaining work relet — see Contract No. 139.)	17	53,578 00	51,465 00†	T. W. Kinser & Sons, Waltham, Mass.
10	122	Pumping engine for the Spot Pond high-service pumping station in Stoneham, Mass.	4	64,000 00	62,500 00†	Holly Mfg. Co., Lockport, N. Y.
11	123	3 36-inch, 2 12-inch, sluice-gates, steel beams and cast-iron floor plates at the Middlesex Fells Reservoir.	3	5,748 00	3,420 00†	Coffin Valve Co., Boston, Mass.

* Contract completed. † Contract based upon this bid. ‡ Informal bid.

DURING THE YEAR 1898 — *Continued.*

relating to the Distributing System — Continued.

Miscellaneous — *Continued.*

7. Date of Contract.	8. Date for Completion of Contract.	9. Date of Final Estimate.	10. Prices of Principal Items of Contracts made in 1898.	11. Amount of Contract.	12. Value of Work done Dec. 31, 1898.	
Oct. 13, '97,	Dec. 15, '97,	Jan. 26, '98,	- -	$21,559 74	$21,559 74	1
Oct. 23, '97,	Dec. 1, '97,	Feb. 5, '98,	- -	1,500 00	1,500 00	2
Oct. 23, '97,	Dec. 23, '97,	Feb. 9, '98,	- -	1,496 00	1,496 00	3
Dec. 8, '97,	Feb. 1, '98,	May 2, '98,	- -	1,930 00	1,930 00	4
Jan. 27, '98,	May 1, '98,	June 28, '98,	For whole work, $3,097.00, .	3,097 00	3,097 00	5
Feb. 12, '98,	-	-	For whole work, $1,569.00, .	1,569 00	1,500 00	6
Mar. 8, '98,	May 8, '98,	Nov. 5, '98,	$0.0112 per pound, . .	998 04	998 04	7
Apr. 4, '98,	Oct. 20, '98,	Dec. 29, '98,	36-inch hydraulic lift valves, $870.00; 48-inch check valve, $1,440.00; 36-inch check valve, $870.00.	8,364 00	8,364 00	8
May 7, '98,	Dec. 1, '98,	Nov. 28, '98,	Earth excavation, $0.19 per cu. yd.; loose rock excavation, $0.50 per cu. yd; solid rock excavation, $1.75 per cu. yd.; Portland cement concrete masonry, $5.50 per cu. yd.; Rosendale cement concrete masonry, $3.95 per cu. yd; plastering of Portland cement, $0.25 per sq. yd.; granite ashlar masonry $20.00 per cu. yd.; granite dimension stone masonry, $75.00 per cu. yd.; slope paving, $1.00 per cu. yd.; laying 36-inch pipe, $1.00 per lin. ft.	35,038 48	35,038 48	9
Sept. 20, '98,	Jan. 20, 1900.	-	Price of engine complete, $62,500.00.	62,500 00	-	10
Aug. 11, '98,	Dec. 1, '98,	-	36-inch sluice gates, $297.50; 12-inch sluice gates, $132 00; steel beams and cast-iron floor plates, $776.00.	3,420 00	2,500 00	11

CONTRACTS MADE AND PENDING

Contracts made by the Metropolitan Water Board

Miscellaneous — *Concluded.*

	1. Number of Contract.	2. WORK.	3. Number of Bids.	AMOUNT OF BID.		6. Contractor.
				4. Next to Lowest.	5. Lowest.	
1	126	Low-service pumping station at Chestnut Hill Reservoir, Boston, Mass.	9	$193,050 00	$182,659 50*	Norcross Bros., Boston, Mass.
2	129†	26 water valves; 10 12-inch, 10 16-inch, 6 20-inch.	3	2,724 00	2,512 00*	Camden Iron Works, Camden, N. J.
3	132	Sluice-gates at the low-service pumping station, Chestnut Hill Reservoir.	4	3,936 00	3,536 00*	The Atlantic Works, Boston, Mass.
4	139	High-service reservoir and gate chamber in the Middlesex Fells in Stoneham, Mass. (second letting).	3	56,683 50	54,871 50*	H. P. Nawn and N. S. Brock, Boston, Mass.
		Total miscellaneous, .	. .	. . .	. . .	. . . .
		Total for Distributing System, . . .	. .	. . .	. . .	. . . .

* Contract based upon this bid.

† Contract completed.

DURING THE YEAR 1898 — *Continued.*

relating to the Distributing System — Concluded.

Miscellaneous — *Concluded.*

7. Date of Contract.	8. Date for Completion of Contract.	9. Date of Final Estimate.	10. Prices of Principal Items of Contracts made in 1898.	11. Amount of Contract.	12. Value of Work done Dec. 31, 1898.	
Aug. 26, '98,	July 15, '99,	-	Excavation, $0.33 per cu. yd.; Rosendale cement concrete masonry, $4.14 per cu. yd.; Portland cement concrete masonry, $5.43 per cu. yd.; brick masonry, $12.00 per cu. yd.; granite stone masonry, $53.19 per cu. yd.; superstructure complete with all appurtenances, $146,400.00.	$192,300 00	$38,000 00	1
Aug. 29, '98,	Jan. 29, '99,	Dec. 24, '98,	20 inch valves, $172.00; 16-inch valves, $110.00; 12-inch valves, $75.00.	2,882 00	2,882 00	2
Sept. 10, '98,	Jan. 1, '99,	-	$442 per gate, . . .	3,536 00	3,000 00	3
Nov. 4, '98,	July 1, '99,	-	Earth excavation, $0.51 per cu. yd.; loose rock excavation, $0.90 per cu. yd.; solid rock excavation, $1.50 per cu. yd.; Portland cement concrete masonry, $7.00 per cu. yd.; Rosendale cement concrete masonry, $5.25 per cu. yd.; plastering of Portland cement, $0.75 per sq. yd.; granite ashlar masonry, $20.00 per cu. yd.; granite dimension stone masonry, $50.00 per cu. yd.; slope paving $2.50 per cu. yd.; laying 36-inch pipe, $1.25 per lin. ft.	54,871 50	4,450 00	4
. . . .	. . .	. . . .	. . . .	$750,133 38	$358,849 86	
. . . .	. . .	. . . .	. . . .	$1,194,792 86	$797,330 81	

CONTRACTS MADE AND PENDING DURING THE YEAR 1898 — *Concluded.*

Summary of Contracts.

	Approximate Amount of Contracts.	Value of Work done Dec. 31, 1898.
Sudbury Reservoir, uncompleted portion of 1 contract made by the city of Boston and assumed by the Metropolitan Water Board, . . .	$91,290 43	$91,290 43
Sudbury Reservoir, 11 contracts made by the Metropolitan Water Board, ...	544,512 01	544,020 01
Wachusett Reservoir, 6 contracts, . . .	127,723 46	104,140 96
Wachusett Aqueduct and Clinton sewerage, 9 contracts, ...	739,945 36	721,715 24
Distributing system, 52 contracts, . . .	1,193,224 53	795,762 48
Total of 79 contracts made and pending during the year 1898, ...	$2,696,695 79	$2,256,929 12
70 contracts completed in 1896 and 1897, . .	3,664,656 14	3,664,656 14
	$6,361,351 93	$5,921,585 26
Deduct for work done on 11 Sudbury Reservoir contracts by the city of Boston, ...	512,000 00	512,000 00
Total of 149 contracts, ...	$5,849,351 93	$5,409,585 26

APPENDIX No. 2.

TESTS OF CEMENT MADE AT THE OFFICE OF THE METROPOLITAN WATER BOARD, DAM AND AQUEDUCT DEPARTMENT, CLINTON, MASS.

The methods of testing were the same as described in Appendix No. 3, of the last annual report of the Metropolitan Water Board. The tests are largely of cements used in 1896 and 1897 for the construction of the Wachusett Aqueduct, but the results of tests of cements used in 1898 are also included in the tables which follow.

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* In this summary only formal contracts are included, so that the totals for the Distribution System differ slightly from those given on page 163.

Tabulation of Cement Tests for All Brands of Natural Cement, of which Nine Hundred Barrels or More were used on Construction Work by the Dam and Aqueduct and Reservoir Departments in 1896, 1897 and 1898.

BRAND.	Number of Barrels used.	Composition of Briquette.	FINENESS.			WIRE TESTS.		TENSILE STRENGTH.																	
								ONE DAY.		SEVEN DAYS.		TWENTY-EIGHT DAYS.		THREE MONTHS.		SIX MONTHS.		ONE YEAR.		EIGHTEEN MONTHS.		TWO YEARS.	
			Per Cent. Residue on No. 50 Sieve, 2,500 Meshes to Square Inch.	Per Cent. Residue on No. 100 Sieve, 10,000 Meshes to Square Inch.	Per Cent. Residue on No. 180 Sieve, 32,400 Meshes to Square Inch.	Minutes to bear Light Wire.	Minutes to bear Heavy Wire.	Number of Briquettes.	Pounds per Square Inch.	Number of Briquettes.	Pounds per Square Inch.	Number of Briquettes.	Pounds per Square Inch.	Number of Briquettes.	Pounds per Square Inch.	Number of Briquettes.	Pounds per Square Inch.	Number of Briquettes.	Pounds per Square Inch.	Number of Briquettes.	Pounds per Square Inch.	Number of Briquettes.	Pounds per Square Inch.
Beach, . .	8,380	Neat	7.5	20.6	-	42	76	892	123	634	136	64	223	64	348	62	380	64	430	14	485	14	491
		1 to 1	-	-	-	36	66	-	-	636	103	64	168	64	317	62	319	64	315	14	331	14	317
Hoffman, .	43,905	Neat	5.9	17.1	-	31	61	4,410	117	2,817	130	117	204	97	341	91	392	91	433	6	468	20	499
		1 to 1	-	-	-	29	52	-	-	2,811	104	141	197	97	315	102	367	91	339	6	316	20	329
Norton, . .	60,877	Neat	8.1	22.4	-	38	89	6,244	115	1,979	128	90	202	70	352	60	390	70	403	-	-	-	-
		1 to 1	-	-	-	35	76	-	-	1,967	96	70	150	70	301	60	291	70	307	-	-	-	-
Union, . .	900	Neat	1.3	9.9	18.1	10	26	183	164	193	167	137	187	67	273	27	317	62	411	12	393	12	363
		1 to 1	-	-	-	10	20	-	-	153	156	36	206	66	312	26	424	65	512	12	553	12	561
Total, .	114,062	Neat	7.1	20.1	-	35	76	11,729	117	5,623	131	408	201	298	330	240	382	287	420	32	447	46	461
		1 to 1	-	-	-	32	63	-	-	5,567	102	311	181	297	311	250	343	290	365	32	411	46	386

Tabulation of Cement Tests for All Brands of Portland Cement, of which Nine Hundred Barrels or More were used on Construction Work by the Dam and Aqueduct Department in 1896, 1897 and 1898.

BRAND.	Number of Barrels used.	Composition of Briquette.	FINENESS.			WIRE TESTS		TENSILE STRENGTH.					
								ONE DAY.		SEVEN DAYS.		TWENTY-EIGHT DAYS.	
			Per Cent. Residue on No. 50 Sieve, 2,500 Meshes to Square Inch.	Per Cent. Residue on No. 100 Sieve, 10,000 Meshes to Square Inch.	Per Cent. Residue on No. 180 Sieve, 32,400 Meshes to Square Inch.	Minutes to bear Light Wire.	Minutes to bear Heavy Wire.	Number of Briquettes.	Pounds per Square Inch.	Number of Briquettes.	Pounds per Square Inch.	Number of Briquettes.	Pounds per Square Inch.
Atlas, ...	17,797	Neat, ...	.4	10.0	24.7	85	426	1,845	393	912	677	95	719
		2 to 1, ...	-	-	-	-	102	-	-	935	322	95	329
Brooks-Shoobridge, ...	5,306	Neat, ...	1.0	11.4	26.0	83	295	462	184	550	443	50	442
		2 to 1, ...	-	-	-	-	182	-	-	550	255	50	311
Giant, ...	15,283	Neat, ...	1.0	9.9	21.9	22	124	1,560	292	667	448	60	483
		2 to 1, ...	-	-	-	-	59	-	-	666	279	60	326
Iron Clad, ...	6,142	Neat, ...	.4	9.3	26.6	82	264	633	403	301	538	25	535
		2 to 1, ...	-	-	-	-	130	-	-	291	308	26	354
Stettin Girstow, ...	979	Neat, ...	2.8	17.9	30.9	130	444	145	288	145	570	54	596
		2 to 1, ...	-	-	-	-	252	-	-	145	373	58	361
West Kent, ...	3,394	Neat, ...	1.7	18.6	31.1	5	88	449	178	449	356	59	456
		2 to 1, ...	-	-	-	-	17	-	-	449	261	59	326
Total, ...	48,901	Neat, ...	.8	10.8	24.8	60	272	5,094	322	3,024	518	343	559
		2 to 1, ...	-	-	-	-	105	-	-	3,036	292	348	333

Tabulation of Cement Tests for All Brands of Portland Cement, etc. — Concluded.

BRAND.	Number of Barrels used.	Composition of Briquette.	Tensile Strength — Concluded. Three Months. Number of Briquettes.	Three Months. Pounds per Square Inch.	Six Months. Number of Briquettes.	Six Months. Pounds per Square Inch.	Nine Months. Number of Briquettes.	Nine Months. Pounds per Square Inch.	One Year. Number of Briquettes.	One Year. Pounds per Square Inch.	Eighteen Months. Number of Briquettes.	Eighteen Months. Pounds per Square Inch.	Two Years. Number of Briquettes.	Two Years. Pounds per Square Inch.
Atlas,	17,797	Neat,	65	742	65	771	50	805	55	803	5	836	-	-
		2 to 1,	65	321	65	329	50	327	55	376	5	378	-	-
Brooks-Shoobridge,	5,806	Neat,	50	528	50	577	-	-	50	663	5	674	18	653
		2 to 1,	50	391	50	417	-	-	50	444	5	521	18	458
Giant,	15,283	Neat,	50	533	50	536	50	572	30	561	5	652	-	-
		2 to 1,	50	387	50	407	50	418	30	439	5	552	-	-
Iron Clad,	6,142	Neat,	14	604	14	650	14	647	14	653	5	730	-	-
		2 to 1,	14	400	14	443	14	442	14	454	5	393	-	-
Stettin-Girstow,	979	Neat,	52	646	52	674	-	-	52	677	8	665	11	677
		2 to 1,	58	379	58	372	-	-	52	357	8	370	13	400
West Kent,	3,394	Neat,	59	524	59	547	-	-	59	597	19	586	20	590
		2 to 1,	59	410	59	434	-	-	59	455	19	522	20	511
Total,	48,901	Neat,	290	601	290	628	114	683	260	669	47	658	49	633
		2 to 1,	296	377	296	392	114	381	260	415	47	470	51	464

APPENDIX No. 3.

TABLE No. 1. — *Monthly Rainfall in Inches at Various Places on the Metropolitan Water Works, in 1898.*

PLACE.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Princeton, . . .	5.54	2.90	2.27	4.21	3.53	3.02	2.68	9.96	3.05	7.60	6.01	4.47	55.24
Jefferson, . . .	6.74	3.33	2.59	4.10	3.32	3.38	3.00	11.89	3.15	7.28	7.50	4.13	60.41
Sterling, ...	6.96	2.94	1.88	4.59	3.29	3.11	2.78	9.88	3.18	7.20	6.24	3.60	55.65
South Clinton, . .	7.38	4.04	2.34	4.81	3.37	2.93	3.57	10.72	3.22	6.76	7.50	3.75	60.39
Framingham, . . .	6.54	4.27	2.40	4.73	3.05	2.24	3.98	7.42	2.09	7.01	7.24	3.30	54.27
Ashland Dam, . .	7.11	4.70	2.40	4.59	3.40	2.25	4.65	7.54	2.81	6.72	6.64	3.28	56.09
Cordaville, . . .	7.27	4.72	2.55	4.86	3.29	2.96	3.76	9.02	3.25	6.55	6.58	3.44	58.25
Lake Cochituate, . .	6.83	4.29	2.54	5.07	3.07	2.08	3.55	7.08	3.03	6.82	6.91	3.44	54.71
Chestnut Hill Reservoir,	5.60	5.58	2.20	6.17	4.45	2.36	5.57	6.06	1.77	7.38	7.42	2.93	57.49
Mystic Lake, . . .	5.62	5.00	2.11	6.21	3.97	2.06	5.57	7.50	2.64	7.37	6.81	3.00	57.86
Average, . . .	6.56	4.18	2.33	4.93	3.47	2.64	3.91	8.71	2.82	7.07	6.89	3.53	57.04

TABLE No. 2. — *Rainfall at Jefferson, Mass., in 1898.*

DAY OF MONTH.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	-	-	-	-	-	-	-	-	0.25†	-	-	-
2,	-	-	0.10‡	0.23‡	-	0.03†	-	-	0.28†	-	-	-
3,	-	-	-	-	*	*	-	-	-	-	-	-
4,	*	-	*	*	0.17†	0.43†	-	0.53†	-	-	-	*
5,	0.30‡	*	0.60‡	0.15‡	*	-	-	1.15†	-	1.92†	-	1.32†
6,	*	0.13†	-	-	0.55†	0.07†	-	-	-	-	0.25†	-
7,	0.33†	-	-	-	-	-	-	-	0.75†	-	-	-
8,	-	-	-	-	-	*	0.11†	0.50†	-	0.25†	-	-
9,	-	-	-	-	-	0.12†	-	-	-	-	-	-
10,	-	-	-	0.07†	-	-	-	*	-	-	*	-
11,	-	-	-	-	0.05†	0.05†	-	3.89†	-	-	1.97†	0.31‡
12,	*	0.15†	0.20†	-	0.11†	0.04†	-	-	-	0.49†	-	-
13,	0.19†	-	-	-	-	*	1.40†	0.15†	-	-	*	-
14,	-	0.05‡	-	*	-	0.83†	-	-	-	*	0.23†	-
15,	*	*	-	*	*	-	-	0.04†	-	1.13†	-	-
16,	0.42‡	0.20‡	-	0.95†	*	-	-	0.13†	0.03†	-	-	-
17,	-	-	0.05‡	0.04†	0.62†	-	-	2.00†	-	-	*	-
18,	-	-	-	-	-	*	-	*	0.08†	-	*	-
19,	-	*	*	*	0.13†	0.53†	0.70†	1.89†	-	0.93†	*	*
20,	1.40‡	*	0.60†	0.45†	-	*	-	-	-	-	1.68†	*
21,	-	*	-	-	-	0.23†	0.04†	-	-	*	-	0.42§
22,	*	2.60‖	*	*	-	0.45†	-	-	-	1.23†	-	*
23,	1.15§	0.20§	0.24†	*	*	-	-	0.75†	*	-	-	0.57†
24,	-	-	-	*	*	-	-	0.58†	1.72†	-	0.52‡	-
25,	*	-	-	*	*	0.44†	-	0.28†	-	-	-	-
26,	0.95‡	-	-	1.68†	*	-	-	-	0.04†	1.12†	*	-
27,	-	-	-	-	*	-	*	-	-	-	2.60‡	0.08‡
28,	-	-	*	*	1.67†	0.16†	0.48†	-	-	-	-	-
29,	-	-	*	0.53‖	-	-	-	-	-	*	-	-
30,	-	-	0.37†	-	-	-	0.04†	-	-	0.21†	0.25‡	-
31,	2.00‡	-	0.43‡	-	0.02†	-	0.23†	-	-	-	-	1.42‡
Totals,	6.74	3.33	2.59	4.10	3.32	3.38	3.00	11.89	3.15	7.28	7.50	4.13

Total for the year, 60.41 inches.

* Rainfall included in that of following day. † Rain. ‡ Snow.
§ Rain and snow. ‖ Rain, snow and hail.

TABLE NO. 3. — *Rainfall at Framingham, Mass., in 1898.*

DAY OF MONTH.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	-	0.35‡	-	-	-	*	-	-	0.46†	-	-	-
2,	-	-	-	0.23‡	-	*	-	-	0.03†	-	-	-
3,	-	-	0.06‡	-	*	*	-	-	-	-	-	-
4,	*	-	*	-	0.10†	*	0.03†	0.43†	-	-	-	*
5,	0.17‡	0.14†	0.67‡	*	*	0.86†	-	1.52†	-	1.00†	-	0.93†
6,	0.20†	-	-	0.32‡	0.33†	0.01†	-	-	-	-	0.26†	-
7,	-	-	-	-	-	-	-	-	0.49†	*	-	-
8,	-	-	-	-	-	0.03†	-	0.24†	-	0.19†	-	-
9,	-	-	-	-	-	-	0.18†	0.11†	-	-	-	-
10,	-	-	-	0.09†	-	-	-	*	-	-	1.82†	-
11,	-	-	-	-	0.02†	0.02†	-	2.33†	-	-	-	-
12,	*	0.15†	0.19†	-	0.02†	-	-	*	-	0.97†	-	0.32‡
13,	0.10‡	-	-	-	-	*	2.21†	0.23†	-	-	-	-
14,	-	0.02‡	-	*	-	0.27†	-	-	-	0.99†	0.16†	-
15,	*	0.03§	-	*	*	-	-	0.02†	-	0.08†	-	-
16,	0.36§	0.30‡	-	0.65†	0.50†	-	-	-	0.13†	-	-	-
17,	-	-	0.03†	0.02†	-	-	-	1.46†	-	-	*	-
18,	-	-	-	-	-	-	*	*	0.03†	-	*	-
19,	-	*	0.41†	*	*	0.72†	0.50†	0.57†	-	*	1.92†	-
20,	1.27§	*	0.05†	0.50†	0.06†	0.14†	-	-	-	0.79†	-	*
21,	-	*	-	-	-	-	0.44†	-	-	*	-	0.49§
22,	*	3.14†	*	*	-	0.14†	-	-	*	1.21†	-	*
23,	1.04§	0.14‡	0.18§	*	*	-	-	0.30†	0.64†	-	-	0.62†
24,	-	-	-	*	*	-	-	0.14†	*	-	*	-
25,	*	-	-	2.22†	*	-	-	0.03†	0.19†	-	0.36§	-
26,	0.75‡	-	-	0.05†	*	-	0.08†	-	0.12†	*	*	-
27,	-	-	-	-	*	-	-	0.04†	-	1.49†	2.22‡	-
28,	-	-	-	*	2.00†	0.05†	*	-	-	-	-	0.04‡
29,	-	-	*	*	-	-	0.38†	-	-	*	-	-
30,	-	-	0.36†	0.65†	-	-	0.10†	-	-	0.29†	0.50‡	*
31,	2.65‡	-	0.45§	-	0.02†	-	0.06†	-	-	-	-	0.90§
Totals,	6.54	4.27	2.40	4.73	3.05	2.24	3.98	7.42	2.09	7.01	7.24	3.30

Total for the year, 54.27 inches.

*** Rainfall included in that of following day. † Rain. ‡ Snow. § Rain and snow.**

TABLE No. 4. — *Rainfall at Chestnut Hill Reservoir in 1898.*

DATE.	Inches.	Rain or Snow.	Duration.
Jan. 4,	0.09	Snow.	7.00 P.M. to
Jan. 5,			3.00 A.M.
Jan. 6,	0.25	Rain.	10.00 P.M. to
Jan. 7,			8.30 A.M.
Jan. 12,	0.06	Rain.	5.30 P.M. to 9.30 P.M.
Jan. 15,	0.34	Snow and rain.	9.30 A.M. to
Jan. 16,			3.00 A.M.
Jan. 20,	1.15	Snow and rain.	8.00 A.M. to 10.00 P.M.
Jan. 22,	1.24	Snow and rain.	10.30 P.M. to
Jan. 23,			2.45 P.M.
Jan. 25,	0.91	Snow.	9.00 P.M. to
Jan. 26,			2.30 P.M.
Jan. 31,	1.56	Snow.	7.45 A.M. to midnight.
Total,	5.60		
Feb. 1,	1.37	Snow.	Midnight Jan. 31 to 2.00 P.M.
Feb. 5,	0.24	Rain.	10.00 P.M. to
Feb. 6,			2.00 A.M.
Feb. 12,	0.13	Rain.	11.45 A.M. to 4.00 P.M.
Feb. 15,	0.04	Rain.	9.30 P.M. to 10.00 P.M.
Feb. 16,	0.10	Snow.	7.10 A.M. to 6.30 P.M.
Feb. 20,	3.48	Rain.	10.15 A.M.
Feb. 21,			to
Feb. 22,			11.30 A.M.
Feb. 23,	0.22	Snow and rain.	5.45 A.M. to 10.00 A.M.
Total,	5.58		
Mar. 3,	0.13	Snow.	4.00 A.M. to 2.00 P.M.
Mar. 4,	0.56	Snow.	4.15 P.M. to
Mar. 5,			2.30 A.M.
Mar. 12,	0.05	Rain.	2.00 P.M. to 5.30 P.M.
Mar. 17,	0.03	Rain.	6.00 A.M. to 9.00 A.M.
Mar. 19,	0.41	Rain.	3.00 A.M. to 2.00 P.M.
Mar. 20,	0.03	Rain.	12.10 A.M. to 3.00 A.M.
Mar. 22,	0.15	Rain.	4.30 P.M. to
Mar. 23,			6.30 A.M.
Mar. 29,	0.34	Rain.	5.00 P.M. to
Mar. 30,			7.30 A.M.
Mar. 31,	0.50	Snow and rain.	4.30 A.M. to 2.30 P.M.
Total,	2.20		
Apr. 2,	0.19	Rain and snow.	5.15 P.M. to 11.30 P.M.
Apr. 5,	0.42	Snow.	5.00 A.M. to
Apr. 6,			4.30 A.M.
Apr. 10,	0.14	Rain.	1.30 P.M. to
Apr. 11,			7.30 A.M.
Apr. 14,	1.05	Rain.	7.30 P.M.
Apr. 15,			to
Apr. 16,			2.30 A.M.
Apr. 19,	0.62	Rain.	3.30 P.M. to
Apr. 20,			7.30 A.M.
Apr. 22,	2.42	Rain.	11.40 P.M.
Apr. 23,			to
Apr. 24,			9.00 P.M.
Apr. 25,	0.15	Rain.	10.30 P.M. to
Apr. 26,			1.30 P.M.
Apr. 28,	1.18	Hail and rain.	1.30 P.M. to
Apr. 29,			11.00 P.M.
Total,	6.17		
May 3,	0.23	Rain.	2.30 P.M. to
May 4,			7.30 A.M.
May 5,	0.34	Rain.	7.00 P.M. to
May 6,			6.30 A.M.
May 15,	0.48	Rain.	2.45 P.M. to
May 16,			11.00 A.M.
May 16,	0.08	Rain.	6.30 P.M. to 11.00 P.M.
May 20,	0.07	Rain.	1.00 A.M. to 2.00 A.M.
May 23,	1.60	Rain.	9.00 P.M.
May 24,			
May 25,			to
May 26,			10.30 A.M.

TABLE No. 4. *Rainfall at Chestnut Hill Reservoir in 1898* — Continued.

Date.	Inches.	Rain or Snow.	Duration.	Date.	Inches.	Rain or Snow.	Duration.
[illegible]	[illegible]	[illegible]	[illegible]	Aug. [illegible]	[illegible]	Rain.	[illegible] P.M. to [illegible] P.M.
[illegible]	[illegible]	[illegible]	[illegible]	Aug. [illegible]	[illegible]	Rain.	[illegible] P.M. to [illegible] P.M.
[illegible]	[illegible]			Aug. [illegible]			[illegible] A.M. to [illegible] A.M.
				Aug. [illegible]	[illegible]	Rain.	[illegible] A.M. to [illegible] A.M.
[illegible]			[illegible]	Totals,	[illegible]		
[illegible]		[illegible]	[illegible]	Sept. [illegible]	[illegible]	Rain.	[illegible] P.M. to [illegible] P.M.
[illegible]			[illegible]	Sept. [illegible]	[illegible]	Rain.	[illegible] P.M. to [illegible] P.M.
[illegible]		[illegible]	[illegible]	Sept. [illegible]	[illegible]	Rain.	[illegible] P.M. to [illegible] P.M.
[illegible]			[illegible]	Sept. [illegible]	[illegible]	Rain.	[illegible] P.M. to [illegible] P.M.
[illegible]	[illegible]	[illegible]	[illegible]	Sept. [illegible]	[illegible]	Rain.	[illegible] P.M. to [illegible] P.M.
[illegible]			[illegible]	Sept. [illegible]	[illegible]	Rain.	[illegible] A.M. to [illegible] A.M.
[illegible]	[illegible]	[illegible]	[illegible]	Sept. [illegible]	[illegible]	Rain.	[illegible] A.M. to [illegible] A.M.
[illegible]	[illegible]	[illegible]	[illegible]	Sept. [illegible]			[illegible] A.M.
[illegible]	[illegible]			Sept. [illegible]	[illegible]	Rain.	[illegible] A.M. to [illegible] A.M.
				Totals,	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE No. 4. — *Rainfall at Chestnut Hill Reservoir in 1898* — Concluded.

DATE.	Inches.	Rain or Snow.	Duration.		DATE.	Inches.	Rain or Snow.	Duration.	
Nov. 17,	0.32	Rain.	8.30 A.M. to		Dec. 4,	0.98	Rain.	1.20 P.M. to	
Nov. 18,				11.15 A.M.	Dec. 5,				2.20 A.M.
Nov. 18,	1.35	Rain.	9.00 P.M. to		Dec. 12,	0.20	Snow.	7.20 A.M. to	10.20 P.M.
Nov. 19,				10.00 P.M.	Dec. 20,	0.44	Snow and rain.	1.20 A.M. to	10.00 P.M.
Nov. 24,	0.38	Rain and snow.	7.00 A.M. to		Dec. 22,	0.57	Rain.	6.20 P.M. to	
Nov. 25,				3.00 A.M.	Dec. 23,				5.00 A.M.
Nov. 26,	2.76	Snow.	7.50 P.M. to		Dec. 31,	0.74	Rain and snow.	5.00 A.M. to	7.00 A.M., January 1, 1899.
Nov. 27,				10.00 P.M.					
Nov. 30,	0.54	Snow.	6.30 A.M. to	3.15 P.M.	Total,	2.93			
Total,	7.42								

Total rainfall for year, 57.40 inches.

TABLE No. 5. — *Rainfall, in Inches, on the Sudbury Watershed,* 1875 to 1898.*

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1875,	2.42	3.15	3.74	3.23	3.56	6.24	3.57	5.53	3.43	4.85	4.83	0.94	45.49
1876,	1.83	4.21	7.43	4.20	2.76	2.04	9.13	1.72	4.62	2.24	5.76	3.62	49.56
1877,	3.22	0.74	8.36	3.43	3.70	2.43	2.95	3.68	0.32	8.52	5.80	0.87	44.02
1878,	5.63	5.97	4.69	5.79	0.96	3.88	2.97	6.94	1.29	6.42	7.02	6.37	57.93
1879,	2.48	3.56	5.14	4.72	1.58	3.79	3.93	6.51	1.88	0.81	2.68	4.34	41.42
1880,	3.57	3.98	3.31	3.11	1.84	2.14	6.27	4.01	1.60	3.74	1.78	2.83	38.18
1881,	5.56	4.65	5.73	2.00	3.51	5.39	2.35	1.36	2.62	2.95	4.09	3.96	44.17
1882,	5.95	4.55	2.65	1.82	5.07	1.66	1.77	1.67	8.74	2.07	1.15	2.30	39.40
1883,	2.81	3.87	1.78	1.84	4.19	2.40	2.68	0.73	1.52	5.60	1.81	3.55	32.78
1884,	5.09	6.54	4.72	4.41	3.47	3.44	3.67	4.65	0.85	2.48	2.65	5.17	47.14
1885,	4.71	3.87	1.07	3.60	3.48	2.87	1.43	7.18	1.43	5.09	6.09	2.72	43.54
1886,	6.36	6.28	3.61	2.22	3.00	1.47	3.27	4.10	2.90	3.24	4.64	4.97	46.06
1887,	5.20	4.78	4.90	4.27	1.16	2.65	3.76	5.28	1.32	2.83	2.67	3.88	42.70
1888,	4.15	3.68	6.02	2.43	4.82	2.54	1.41	6.22	8.59	4.99	7.22	5.40	57.47
1889,	5.37	1.65	2.37	3.41	2.95	2.80	8.94	4.18	4.60	4.25	6.29	3.14	49.95
1890,	2.53	3.51	7.73	2.64	5.21	2.03	2.46	3.87	6.00	10.51	1.20	5.31	53.00
1891,	7.02	5.23	6.48	3.91	2.01	3.77	3.39	4.73	2.38	3.83	3.09	3.68	49.52
1892,	5.85	3.14	4.06	0.83	5.58	2.76	4.23	4.44	2.84	1.17	5.80	1.13	41.83
1893,	2.92	8.20	3.67	3.60	6.61	2.38	2.57	5.41	1.74	4.07	2.20	4.86	48.23
1894,	4.09	3.91	1.43	3.42	4.24	1.15	3.26	2.03	2.63	5.34	3.43	4.81	39.74
1895,	4.06	1.39	2.98	5.25	2.02	2.77	5.04	4.15	2.30	10.68	6.63	3.35	50.62
1896,	2.39	7.18	5.24	1.57	2.57	3.22	2.51	2.40	7.72	3.76	3.02	2.12	43.70
1897,	4.00	2.91	3.66	2.82	4.37	4.46	5.44	3.51	2.94	0.47	6.40	5.21	46.19
1898,	6.83	4.49	2.40	4.66	3.22	2.48	4.09	8.17	2.62	6.71	6.93	3.28	55.88
Totals,	104.04	101.44	103.17	79.18	81.88	70.76	91.09	102.47	76.88	106.62	103.18	87.81	1,108.52
Averages,	4.34	4.23	4.30	3.30	3.41	2.95	3.79	4.27	3.20	4.44	4.30	3.66	46.19

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* Means of observations at several places, as follows: January, 1875, to April, 1876, Lake Cochituate; April to June, 1876, Lake Cochituate, Westborough and Hopkinton; June to December, 1876, Lake Cochituate, Southborough, Marlborough, Westborough and Hopkinton; December, 1876, to January, 1883, Framingham, Southborough, Marlborough, Westborough and Hopkinton; January, 1883, to January, 1884, Framingham and Southborough; January, 1884, to January, 1890, Framingham and Westborough; January, 1890, to May, 1898, Framingham and Ashland Dam; June to December, 1898, Framingham, Ashland Dam, Cordaville and Sudbury Dam.

TABLE No. 6. — *Rainfall collected, in Inches, on the Sudbury Watershed, 1875 to 1898.*

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1875, ...	0.184	2.411	2.862	5.265	2.119	1.501	0.578	0.706	0.858	1.182	2.248	1.041	20.418
1876, ...	1.147	2.282	7.011	5.088	2.081	0.888	0.326	0.728	0.818	0.417	1.878	0.809	28.908
1877, ...	1.174	1.529	8.586	4.182	2.482	1.031	0.360	0.216	0.108	1.127	2.447	2.800	26.487
1878, ...	3.228	3.072	6.200	2.807	2.487	0.878	0.329	0.848	0.277	0.921	2.022	5.607	30.487
1879, ...	1.940	2.756	4.150	5.879	1.987	0.713	0.281	0.705	0.248	0.126	0.355	0.825	18.775
1880, ...	2.000	2.982	2.451	2.017	0.917	0.808	0.315	0.212	0.188	0.181	0.884	0.812	12.182
1881, ...	0.740	2.491	7.142	2.609	1.721	2.809	0.493	0.264	0.840	0.881	0.682	1.888	20.565
1882, ...	2.213	3.872	5.004	1.407	2.304	0.918	0.164	0.099	0.529	0.584	0.862	0.561	18.102
1883, ...	0.597	1.604	2.873	2.380	1.078	0.518	0.306	0.140	0.157	0.881	0.864	0.845	11.188
1884, ...	1.775	4.742	6.702	4.926	1.838	0.719	0.309	0.408	0.076	0.148	0.802	1.650	23.784
1885, ...	2.208	2.182	2.805	3.183	2.883	0.785	0.111	0.429	0.209	0.599	2.088	2.004	18.916
1886, ...	2.606	7.784	3.072	3.361	1.285	0.850	0.206	0.168	0.203	0.200	1.161	1.819	22.825
1887, ...	4.019	4.058	5.116	4.522	1.709	0.714	0.204	0.882	0.191	0.889	0.550	1.147	24.227
1888, ...	1.878	3.255	5.775	4.000	2.012	0.728	0.209	0.077	1.904	3.506	4.761	5.428	35.749
1889, ...	4.963	1.920	2.388	2.484	1.509	1.128	1.180	2.504	1.422	2.104	3.861	3.997	29.050
1890, ...	2.287	2.463	6.498	3.236	2.487	0.980	0.191	0.235	0.790	4.058	2.097	1.776	26.998
1891, ...	5.383	5.616	7.944	4.188	1.030	0.714	0.206	0.290	0.350	0.875	0.520	0.071	27.612
1892, ...	3.355	1.574	3.488	1.004	2.245	0.789	0.382	0.500	0.806	0.224	1.204	0.805	16.486
1893, ...	0.778	2.485	5.789	3.068	5.148	0.759	0.282	0.322	0.187	0.395	0.550	1.421	21.774
1894, ...	1.280	1.596	3.902	2.882	1.408	0.722	0.287	0.578	0.268	0.608	1.442	1.277	16.182
1895, ...	1.844	0.871	4.200	4.841	1.184	0.501	0.411	0.409	0.155	2.460	4.794	3.179	24.190
1896, ...	1.035	4.406	6.841	2.570	0.641	0.689	0.170	0.102	0.669	1.055	1.187	1.171	21.408
1897, ...	1.507	1.718	4.075	2.615	1.652	1.661	1.174	1.008	0.810	0.168	1.570	2.827	20.815
1898, ...	2.022	4.860	4.040	3.108	2.222	0.915	0.411	1.074	0.087	2.069	3.429	3.208	30.489
Totals, . . .	51.746	74.014	121.880	82.780	47.408	20.899	8.770	13.859	10.818	23.698	40.595	46.078	541.609
Averages, . . .	2.156	3.084	5.078	3.450	1.979	0.850	0.365	0.577	0.450	0.987	1.691	1.920	22.567

TABLE NO. 7.—*Yield of the Sudbury Watershed in Gallons per Day per Square Mile* from 1875 to 1898.*

MONTH.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.
January,	103,000	643,000	658,000	1,810,000	700,000	1,120,000	415,000	1,241,000	335,000	995,000	1,235,000	1,461,000	2,589,000
February,	1,496,000	1,368,000	949,000	2,465,000	1,711,000	1,787,000	1,546,000	2,403,000	1,033,000	2,842,000	1,354,000	4,801,000	2,829,000
March,	1,604,000	4,435,000	4,814,000	3,507,000	2,330,000	1,374,000	4,004,000	2,839,000	1,611,000	3,785,000	1,572,000	2,059,000	2,868,000
April,	3,049,000	3,292,000	2,394,000	1,626,000	3,116,000	1,169,000	1,546,000	867,000	1,350,000	2,853,000	1,815,000	1,947,000	2,620,000
May,	1,188,000	1,138,000	1,391,000	1,394,000	1,114,000	514,000	965,000	1,292,000	937,000	1,080,000	1,336,000	720,000	1,009,000
June,	870,000	222,000	597,000	506,000	413,000	175,000	1,338,000	529,000	300,000	416,000	426,000	203,000	413,000
July,	321,000	183,000	202,000	128,000	157,000	176,000	276,000	86,000	115,000	224,000	62,000	116,000	115,000
August,	396,000	405,000	121,000	476,000	395,000	119,000	148,000	55,000	79,000	257,000	240,000	94,000	214,000
September,	207,000	184,000	60,000	161,000	141,000	80,000	197,000	307,000	91,000	44,000	121,000	117,000	111,000
October,	646,000	234,000	631,000	516,000	71,000	102,000	186,000	299,000	186,000	83,000	336,000	146,000	190,000
November,	1,302,000	1,088,000	1,418,000	1,693,000	206,000	205,000	395,000	209,000	205,000	175,000	1,177,000	673,000	369,000
December,	584,000	453,000	1,290,000	3,177,000	463,000	175,000	775,000	315,000	194,000	925,000	1,174,000	1,020,000	643,000
Average for year,	972,000	1,135,000	1,214,000	1,452,000	804,000	578,000	979,000	862,000	588,000	1,129,000	901,000	1,087,000	1,154,000
Average for driest 6 months,	574,000	384,000	502,000	532,000	230,000	143,000	330,000	211,000	145,000	200,000	391,000	223,000	234,000

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* The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878 inclusive, and subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.[illegible] per cent. in 1885, 8.9 per cent. in 1894 and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

TABLE No. 7. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile* from 1875 to 1898* — Concluded.

MONTH.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	Mean for 24 years, 1875-98.
January,	1,053,000	2,782,000	1,264,000	3,018,000	1,870,000	484,000	693,000	1,031,000	1,084,000	845,000	1,638,000	1,209,000
February,	1,950,000	1,196,000	1,529,000	3,486,000	943,000	1,842,000	991,000	541,000	2,676,000	1,067,000	3,022,000	1,897,000
March,	3,238,000	1,838,000	3,643,000	4,458,000	1,956,000	3,246,000	2,288,000	2,410,000	5,850,000	2,565,000	2,004,000	2,847,000
April,	2,645,000	1,410,000	1,875,000	2,397,000	871,000	2,126,000	1,640,000	2,515,000	1,494,000	1,515,000	1,829,000	1,998,000
May,	1,632,000	880,000	1,366,000	583,000	1,259,000	2,883,000	840,000	686,000	300,000	915,000	1,246,000	1,110,000
June,	421,000	653,000	568,000	418,000	428,000	440,000	419,000	174,000	190,000	962,000	590,000	492,000
July,	117,000	634,000	107,000	149,000	214,000	158,000	161,000	231,000	95,000	658,000	281,000	205,000
August,	379,000	1,452,000	132,000	163,000	280,000	181,000	209,000	229,000	57,000	591,000	1,107,000	323,000
September,	1,155,000	823,000	457,000	203,000	229,000	108,000	150,000	89,000	358,000	182,000	369,000	249,000
October,	1,909,000	1,230,000	2,272,000	210,000	126,000	222,000	874,000	1,379,000	592,000	94,000	1,160,000	553,000
November,	2,758,000	1,941,000	1,215,000	305,000	697,000	319,000	836,000	2,777,000	659,000	900,000	1,986,000	990,000
December,	3,048,000	2,241,000	996,000	554,000	485,000	796,000	716,000	1,782,000	657,000	1,554,000	1,799,000	1,076,000
Average for year,	1,697,000	1,383,000	1,285,000	1,515,000	781,000	1,037,000	770,000	1,152,000	1,019,000	991,000	1,450,000	1,074,000
Average for driest 6 months,	953,000	944,000	747,000	259,000	827,000	287,000	856,000	400,000	314,000	564,000	777,000	465,000

* The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878 inclusive, and subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894 and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

TABLE No. 3.—*Rainfall at Framingham, Mass., in 1898.*

DAY OF MONTH.	January.	February	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1, ...	-	0.35‡	-	-	-	*	-	-	0.46†	-	-	-
2, ...	-	-	-	0.23‡	-	*	-	-	0.03†	-	-	-
3, ...	-	-	0.06‡	-	*	*	-	-	-	-	-	-
4, ...	*	-	*	-	0.10†	*	0.03†	0.43†	-	-	-	*
5, ...	0.17‡	0.14†	0.67‡	*	*	0.86†	-	1.52†	-	1.00†	-	0.93†
6, ...	0.20†	-	-	0.32‡	0.33†	0.01†	-	-	-	-	0.26†	-
7, ...	-	-	-	-	-	-	-	-	0.49†	*	-	-
8, ...	-	-	-	-	-	0.03†	-	0.24†	-	0.19†	-	-
9, ...	-	-	-	-	-	-	0.18†	0.11†	-	-	-	-
10, ...	-	-	-	0.09†	-	-	-	*	-	-	1.82†	-
11, ...	-	-	-	-	0.02†	0.02†	-	2.33†	-	-	-	-
12, ...	*	0.15†	0.19†	-	0.02†	-	-	*	-	0.97†	-	0.32‡
13, ...	0.10‡	-	-	-	-	*	2.21†	0.23†	-	-	-	-
14, ...	-	0.02‡	-	*	-	0.27†	-	-	-	0.99†	0.16†	-
15, ...	*	0.03§	-	*	*	-	-	0.02†	-	0.08†	-	-
16, ...	0.36§	0.30‡	-	0.65†	0.50†	-	-	-	0.13†	-	-	-
17, ...	-	-	0.03†	0.02†	-	-	-	1.46†	-	-	*	-
18, ...	-	-	-	-	-	-	*	*	0.03†	-	*	-
19, ...	-	*	0.41†	*	*	0.72†	0.50†	0.57†	-	*	1.92†	-
20, ...	1.27§	*	0.05†	0.50†	0.06†	0.14†	-	-	-	0.79†	-	*
21, ...	-	*	-	-	-	-	0.44†	-	-	*	-	0.49§
22, ...	*	3.14†	*	*	-	0.14†	-	-	*	1.21†	-	*
23, ...	1.04§	0.14‡	0.18§	*	*	-	-	0.30†	0.64†	-	-	0.62†
24, ...	-	-	-	*	*	-	-	0.14†	*	-	*	-
25, ...	*	-	-	2.22†	*	-	-	0.03†	0.19†	-	0.36§	-
26, ...	0,75‡	-	-	0.05†	*	-	0.08†	-	0.12†	*	*	-
27, ...	-	-	-	-	*	-	-	0.04†	-	1.49†	2.22‡	-
28, ...	-	-	-	*	2.00†	0.05†	*	-	-	-	-	0.04‡
29, ...	-	-	*	*	-	-	0.38†	-	-	*	-	-
30, ...	-	-	0.36†	0.65†	-	-	0.10†	-	-	0.29†	0.50‡	*
31, ...	2.65‡	-	0.45§	-	0.02†	-	0.06†	-	-	-	-	0.90§
Totals, ...	6.54	4.27	2.40	4.73	3.05	2.24	3.98	7.42	2.09	7.01	7.24	3.30

Total for the year, 54.27 inches.

*** Rainfall included in that of following day. † Rain. ‡ Snow. § Rain and snow.**

TABLE No. 4. — *Rainfall at Chestnut Hill Reservoir in 1898.*

DATE.	Inches.	Rain or Snow.	Duration.
Jan. 4,	0.09	Snow.	7.00 P.M. to
Jan. 5,			3.00 A.M.
Jan. 6,	0.25	Rain.	10.00 P.M. to
Jan. 7,			8.30 A.M.
Jan. 12,	0.06	Rain.	5.30 P.M. to 9.30 P M.
Jan. 15,	0.34	Snow and rain.	9.30 A.M. to
Jan. 16,			3.00 A.M.
Jan. 20,	1.15	Snow and rain.	3.00 A.M. to 10.00 P.M.
Jan. 22,	1.24	Snow and rain.	10.30 P.M. to
Jan. 23,			2.45 P.M.
Jan. 25,	0.91	Snow.	9.00 P.M. to
Jan. 26,			2.30 P.M.
Jan. 31,	1.56	Snow.	7.45 A.M. to midnight.
Total,	5.60		
Feb. 1,	1.37	Snow.	Midnight Jan. 31 to 2.00 P.M.
Feb. 5,	0.24	Rain.	10.00 P.M. to
Feb. 6,			2.00 A.M.
Feb. 12,	0.13	Rain.	11.45 A M. to 4.00 P.M.
Feb. 15,	0.04	Rain.	9.30 P.M. to 10.00 P.M.
Feb. 16,	0.10	Snow.	7.10 A.M. to 6.30 P.M.
Feb. 20,	3.48	Rain.	10.15 A.M.
Feb. 21,			to
Feb. 22,			11.30 A.M.
Feb. 23,	0.22	Snow and rain.	5.45 A.M. to 10.00 A.M.
Total,	5.58		
Mar. 3,	0.13	Snow.	4.00 A.M. to 2.00 P.M.
Mar. 4,	0.56	Snow.	4.15 P.M. to
Mar. 5,			2.30 A M.
Mar. 12,	0.05	Rain.	2.00 P.M. to 5.30 P.M.
Mar. 17,	0.03	Rain.	6.00 A.M. to 9.00 A.M.
Mar. 19,	0.41	Rain.	3.00 A.M. to 2.00 P.M.
Mar. 20,	0.03	Rain.	12.10 A.M. to 3.00 A.M.
Mar. 22,	0.15	Rain.	4.30 P.M. to
Mar. 23,			6.30 A M.
Mar. 29,	0.34	Rain.	5.00 P.M. to
Mar. 30,			7.30 A.M.
Mar. 31,	0.50	Snow and rain.	4.30 A.M. to 2.30 P.M.
Total,	2.20		
Apr. 2,	0.19	Rain and snow.	5.15 P.M. to 11.30 P.M.
Apr. 5,	0.42	Snow.	5.00 A.M. to
Apr. 6,			4.30 A.M.
Apr. 10,	0.14	Rain.	1.30 P.M. to
Apr. 11,			7.30 A.M.
Apr. 14,	1.05	Rain.	7.30 P.M.
Apr. 15,			to
Apr. 16,			2.30 A.M.
Apr. 19,	0.62	Rain.	3.30 P.M. to
Apr. 20,			7.30 A.M.
Apr. 22,	2.42	Rain.	11.40 P.M.
Apr. 23,			to
Apr. 24,			9.00 P.M.
Apr. 25,	0.15	Rain.	10.30 P.M. to
Apr. 26,			1.30 P.M.
Apr. 28,	1.18	Hail and rain.	1.30 P.M. to
Apr. 29,			11.00 P.M.
Total,	6.17		
May 3,	0.23	Rain.	2.30 P.M. to
May 4,			7.30 A.M.
May 5,	0.34	Rain.	7.00 P.M. to
May 6,			6.30 A M.
May 15,	0.48	Rain.	2.45 P.M. to
May 16,			11.00 A.M.
May 16,	0.06	Rain.	6.30 P.M. to 11.00 P.M.
May 20,	0.07	Rain.	1.00 A.M. to 2.00 A.M.
May 23,	1.60	Rain.	9.00 P.M.
May 24,			
May 25,			to
May 26,			10.30 A.M.

Table No. 4. — *Rainfall at Chestnut Hill Reservoir in 1898* — Continued.

DATE.	Inches.	Rain or Snow.	Duration.
May 26,	1.65	Rain.	8.15 P.M. to
May 27,			3.00 P.M.
Total,	4.45		
June 2,	1.07	Rain.	6.30 P.M.
June 3,			to
June 4,			8.30 P.M.
June 13,	0.20	Rain.	9.00 P.M. to
June 14,			6.30 A.M.
June 19,	0.84	Rain.	9.00 A.M. to 3.30 P.M.
June 20,	0.20	Rain.	8.30 P.M. to
June 21,			4.30 P.M.
June 28,	0.05	Rain.	6.30 A.M. to 9.30 A.M.
Total,	2.36		
July 4,	0.75	Rain.	4.10 P.M. to 11.45 P.M.
July 9,	0.31	Rain.	6.10 A.M. to 11.30 A.M.
July 13,	2.55	Rain.	2.30 A.M. to 11.30 P.M.
July 19,	0.59	Rain.	12.45 A.M. to 4.00 A.M.
July 21,	0.57	Rain.	3.00 P.M. to 5.30 P.M.
July 26,	0.20	Rain.	3.40 P.M. to 7.30 P.M.
July 28,	0.37	Rain.	6.30 A.M. to 8.30 P.M.
July 30,	0.20	Rain.	4.30 P.M. to 6.30 P.M.
July 31,	0.03	Rain.	2.30 P.M. to 3.30 P.M.
Total,	5.57		
Aug. 4,	0.32	Rain.	4.00 A.M. to 6.30 A.M.
Aug. 5,	1.15	Rain.	4.00 A.M. to 12.15 P.M.
Aug. 8,	0.24	Rain.	6.00 A.M. to 7.00 A.M.
Aug. 8,	0.06	Rain.	5.30 P.M. to 10.30 P.M.
Aug. 10,	2.22	Rain.	1.30 P.M. to
Aug. 11,			8.30 A.M.
Aug. 11,	0.14	Rain.	10.30 A.M. to 6.30 P.M.
Aug. 13,	0.25	Rain.	12.45 A.M. to 6.00 A.M.
Aug. 17,	0.19	Rain.	5.15 P.M. to 7.30 P.M.
Aug. 18,	0.86	Rain.	11.45 P.M. to
Aug. 19,			4.15 P.M.
Aug. 19,	0.10	Rain.	5.00 P.M. to 6.15 P.M.
Aug. 23,	0.44	Rain.	6.40 P.M. to 9.15 P.M.
Aug. 24,			3.00 A.M. to 4.30 A.M.
Aug. 25,	0.09	Rain.	11.20 A.M. to 11.35 A.M.
Total,	6.06		
Sept. 1,	0.03	Rain.	2.45 P.M. to 7.00 P.M.
Sept. 2,	0.09	Rain.	8.30 P.M. to 10.00 P.M.
Sept. 7,	0.44	Rain.	5.30 P.M. to 10.00 P.M.
Sept. 16,	0.04	Rain.	5.30 P.M. to 6.15 P.M.
Sept. 18,	0.03	Rain.	3.40 P.M. to 4.10 P.M.
Sept. 23,	0.75	Rain.	4.15 A.M. to 11.45 A.M.
Sept. 24,	0.12	Rain.	6.30 A.M. to
Sept. 25,			11.30 A.M.
Sept. 27,	0.27	Rain.	12.15 A.M. to 6.00 A.M.
Total,	1.77		
Oct. 4,	1.22	Rain.	11.30 P.M. to
Oct. 5,			8.00 P.M.
Oct. 8,	0.22	Rain.	4.00 A.M. to 2.30 P.M.
Oct. 12,	0.72	Rain.	12.15 A.M. to 7.30 A.M.
Oct. 12,	0.03	Rain.	10.00 A.M. to 10.30 A.M.
Oct. 14,	0.92	Rain.	9.00 P.M. to
Oct. 15,			4.30 P.M.
Oct. 19,	0.88	Rain.	11.30 A.M. to 10.00 P.M.
Oct. 21,	1.49	Rain.	3.00 A.M. to
Oct. 22,			4.30 P.M.
Oct. 26,	1.76	Rain.	6.45 A.M. to
Oct. 27,			4.00 A.M.
Oct. 29,	0.11	Rain.	9.30 A.M. to
Oct. 30,			5.00 A.M.
Oct. 30,	0.03	Rain.	12.15 P.M. to 2.00 P.M.
Total,	7.38		
Nov. 6,	0.39	Rain.	7.15 A.M. to 2.30 P.M.
Nov. 10,	1.50	Rain.	4.00 A.M. to 7.00 A.M.
Nov. 13,	0.18	Rain.	11.00 P.M. to
Nov. 14,			4.30 A.M.

TABLE No. 4. — *Rainfall at Chestnut Hill Reservoir in 1898* — Concluded.

DATE.	Inches.	Rain or Snow.	Duration.
Nov. 17,	0.32	Rain.	8.30 A.M. to
Nov. 18,			11.15 A.M.
Nov. 18,	1.35	Rain.	9.00 P.M. to
Nov. 19,			10.00 P.M.
Nov. 24,	0.38	Rain and snow.	7.00 A.M. to
Nov. 25,			3.00 A.M.
Nov. 26,	2.76	Snow.	7.50 P.M. to
Nov. 27,			10.00 P.M.
Nov. 30,	0.54	Snow.	6.30 A.M. to 3.15 P.M.
Total,	7.42		
Dec. 4,	0.88	Rain.	1.30 P.M. to
Dec. 5,			3.30 A.M.
Dec. 12,	0.30	Snow.	7.30 A.M. to 10.30 P.M.
Dec. 20,	0.44	Snow and rain.	1.30 A.M. to 10.00 P.M.
Dec. 22,	0.57	Rain.	6.30 P.M. to
Dec. 23,			5.00 A.M.
Dec. 31,	0.74	Rain and snow.	5.00 A.M. to 7.00 A.M., January 1, 1899.
Total,	2.93		

Total rainfall for year, 57.49 inches.

TABLE No. 5. — *Rainfall, in Inches, on the Sudbury Watershed,* 1875 to 1898.*

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1875,	2.42	3.15	3.74	3.23	3.56	6.24	3.57	5.53	3.43	4.85	4.83	0.94	45.49
1876,	1.83	4.21	7.43	4.20	2.76	2.04	9.13	1.72	4.62	2.24	5.76	3.62	49.56
1877,	3.22	0.74	8.36	3.43	3.70	2.43	2.95	3.68	0.32	8.52	5.80	0.87	44.02
1878,	5.63	5.97	4.69	5.79	0.96	3.88	2.97	6.94	1.29	6.42	7.02	6.37	57.93
1879,	2.48	3.56	5.14	4.72	1.58	3.79	3.93	6.51	1.88	0.81	2.68	4.34	41.42
1880,	3.57	3.98	3.31	3.11	1.84	2.14	6.27	4.01	1.60	3.74	1.78	2.83	38.18
1881,	5.56	4.65	5.73	2.00	3.51	5.39	2.35	1.36	2.62	2.95	4.09	3.96	44.17
1882,	5.95	4.55	2.65	1.82	5.07	1.66	1.77	1.67	8.74	2.07	1.15	2.30	39.40
1883,	2.81	3.87	1.78	1.84	4.19	2.40	2.68	0.73	1.52	5.60	1.81	3.55	32.78
1884,	5.09	6.54	4.72	4.41	3.47	3.44	3.67	4.65	0.85	2.48	2.65	5.17	47.14
1885,	4.71	3.87	1.07	3.60	3.48	2.87	1.43	7.18	1.43	5.09	6.09	2.72	43.54
1886,	6.36	6.28	3.61	2.22	3.00	1.47	3.27	4.10	2.90	3.24	4.64	4.97	46.06
1887,	5.20	4.78	4.90	4.27	1.16	2.65	3.76	5.28	1.32	2.83	2.67	3.88	42.70
1888,	4.15	3.68	6.02	2.43	4.82	2.54	1.41	6.22	8.59	4.99	7.22	5.40	57.47
1889,	5.37	1.65	2.37	3.41	2.95	2.80	8.94	4.18	4.60	4.25	6.29	3.14	49.95
1890,	2.53	3.51	7.73	2.64	5.21	2.03	2.46	3.87	6.00	10.51	1.20	5.31	53.00
1891,	7.02	5.23	6.48	3.91	2.01	3.77	3.39	4.73	2.38	3.83	3.09	3.68	49.52
1892,	5.85	3.14	4.06	0.83	5.58	2.76	4.23	4.44	2.84	1.17	5.80	1.13	41.83
1893,	2.92	8.20	3.67	3.60	6.61	2.38	2.57	5.41	1.74	4.07	2.20	4.86	48.23
1894,	4.09	3.91	1.43	3.42	4.24	1.15	3.26	2.03	2.63	5.34	3.43	4.81	39.74
1895,	4.06	1.39	2.98	5.25	2.02	2.77	5.04	4.15	2.30	10.68	6.63	3.35	50.62
1896,	2.39	7.18	5.24	1.57	2.57	3.22	2.51	2.40	7.72	3.76	3.02	2.12	43.70
1897,	4.00	2.91	3.66	2.82	4.37	4.46	5.44	3.51	2.94	0.47	6.40	5.21	46.19
1898,	6.83	4.49	2.40	4.66	3.22	2.48	4.09	8.17	2.62	6.71	6.93	3.28	55.88
Totals,	104.04	101.44	103.17	79.18	81.88	70.76	91.09	102.47	76.88	106.62	103.18	87.81	1,108.52
Averages,	4.34	4.23	4.30	3.30	3.41	2.95	3.79	4.27	3.20	4.44	4.30	3.66	46.19

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* Means of observations at several places, as follows: January, 1875, to April, 1876, Lake Cochituate; April to June, 1876, Lake Cochituate, Westborough and Hopkinton; June to December, 1876, Lake Cochituate, Southborough, Marlborough, Westborough and Hopkinton; December, 1876, to January, 1883, Framingham, Southborough, Marlborough, Westborough and Hopkinton; January, 1883, to January, 1884, Framingham and Southborough; January, 1884, to January, 1890, Framingham and Westborough; January, 1890, to May, 1898, Framingham and Ashland Dam; June to December, 1898, Framingham, Ashland Dam, Cordaville and Sudbury Dam.

Table No. 6. — *Rainfall collected, in Inches, on the Sudbury Watershed, 1875 to 1898.*

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1875,	0.184	2.411	2.862	5.263	2.119	1.501	0.573	0.706	0.358	1.152	2.248	1.041	20.418
1876,	1.147	2.282	7.911	5.683	2.081	0.383	0.326	0.728	0.318	0.417	1.878	0.809	23.908
1877,	1.174	1.529	8.586	4.132	2.482	1.031	0.360	0.216	0.103	1.127	2.447	2.300	25.487
1878,	3.228	3.972	6.256	2.807	2.487	0.873	0.229	0.848	0.277	0.921	2.922	5.667	30.487
1879,	1.249	2.756	4.156	5.379	1.987	0.713	0.281	0.705	0.243	0.126	0.355	0.825	18.775
1880,	2.000	2.982	2.451	2.017	0.917	0.303	0.315	0.212	0.188	0.181	0.354	0.812	12.182
1881,	0.740	2.491	7.142	2.669	1.721	2.809	0.493	0.264	0.340	0.331	0.682	1.883	20.565
1882,	2.213	3.872	5.064	1.497	2.304	0.918	0.154	0.099	0.529	0.584	0.362	0.561	18.102
1883,	0.597	1.664	2.873	2.380	1.673	0.518	0.206	0.140	0.157	0.331	0.354	0.345	11.188
1884,	1.775	4.742	6.752	4.925	1.838	0.719	0.899	0.458	0.076	0.148	0.802	1.650	23.784
1885,	2.208	2.182	2.805	3.133	2.383	0.735	0.111	0.429	0.209	0.599	2.033	2.094	18.916
1886,	2.606	7.734	3.672	3.361	1.285	0.350	0.206	0.168	0.203	0.200	1.161	1.819	22.825
1887,	4.619	4.558	5.116	4.522	1.799	0.714	0.204	0.382	0.191	0.839	0.636	1.147	24.227
1888,	1.878	3.255	5.775	4.666	2.912	0.728	0.209	0.677	1.994	3.566	4.761	5.428	35.749
1889,	4.963	1.926	2.388	2.434	1.569	1.128	1.130	2.554	1.422	2.194	3.351	3.997	29.056
1890,	2.237	2.463	6.498	3.236	2.437	0.980	0.191	0.235	0.790	4.053	2.097	1.776	26.998
1891,	5.383	5.616	7.944	4.138	1.039	0.714	0.266	0.290	0.350	0.375	0.526	0.971	27.612
1892,	3.335	1.574	3.488	1.504	2.245	0.789	0.382	0.500	0.396	0.224	1.204	0.865	16.456
1893,	0.778	2.485	5.789	3.668	5.143	0.759	0.282	0.322	0.187	0.395	0.550	1.421	21.774
1894,	1.236	1.596	3.992	2.832	1.498	0.722	0.287	0.378	0.258	0.668	1.442	1.277	16.182
1895,	1.844	0.871	4.299	4.341	1.134	0.301	0.411	0.400	0.153	2.460	4.794	3.179	24.196
1896,	1.933	4.466	6.841	2.579	0.641	0.689	0.170	0.102	0.669	1.055	1.137	1.171	21.453
1897,	1.507	1.718	4.575	2.615	1.632	1.661	1.174	1.053	0.315	0.168	1.570	2.827	20.815
1898,	2.922	4.860	4.645	3.158	2.222	0.915	0.411	1.974	0.637	2.069	3.429	3.208	30.459
Totals,	51.746	74.014	121.880	82.789	47.498	20.399	8.770	13.839	10.313	23.693	40.595	46.078	541.609
Averages,	2.156	3.084	5.078	3.450	1.979	0.850	0.365	0.577	0.430	0.987	1.691	1.920	22.567

TABLE No. 7.—*Yield of the Sudbury Watershed in Gallons per Day per Square Mile* from 1875 to 1898.*

MONTH.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.
January, ...	103,000	643,000	658,000	1,810,000	700,000	1,120,000	415,000	1,241,000	335,000	995,000	1,235,000	1,461,000	2,589,000
February, ...	1,496,000	1,368,000	949,000	2,465,000	1,711,000	1,787,000	1,546,000	2,403,000	1,033,000	2,842,000	1,354,000	4,801,000	2,829,000
March, ...	1,604,000	4,435,000	4,814,000	3,507,000	2,330,000	1,374,000	4,004,000	2,839,000	1,611,000	3,785,000	1,572,000	2,059,000	2,868,000
April, ...	3,049,000	3,292,000	2,394,000	1,626,000	3,116,000	1,169,000	1,546,000	867,000	1,350,000	2,853,000	1,815,000	1,947,000	2,620,000
May, ...	1,188,000	1,138,000	1,391,000	1,394,000	1,114,000	514,000	965,000	1,292,000	937,000	1,030,000	1,336,000	720,000	1,009,000
June, ...	870,000	222,000	597,000	506,000	413,000	175,000	1,338,000	529,000	300,000	416,000	426,000	203,000	413,000
July, ...	321,000	183,000	202,000	128,000	157,000	176,000	276,000	86,000	115,000	224,000	62,000	116,000	115,000
August, ...	396,000	405,000	121,000	476,000	395,000	119,000	148,000	55,000	79,000	257,000	240,000	94,000	214,000
September, ...	207,000	184,000	60,000	161,000	141,000	80,000	197,000	307,000	91,000	44,000	121,000	117,000	111,000
October, ...	646,000	234,000	631,000	516,000	71,000	102,000	186,000	299,000	186,000	83,000	336,000	146,000	190,000
November, ...	1,302,000	1,088,000	1,418,000	1,693,000	206,000	205,000	395,000	209,000	205,000	175,000	1,177,000	673,000	369,000
December, ...	584,000	453,000	1,290,000	3,177,000	463,000	175,000	775,000	315,000	194,000	925,000	1,174,000	1,020,000	643,000
Average for year, . . .	972,000	1,135,000	1,214,000	1,452,000	894,000	578,000	979,000	862,000	533,000	1,129,000	901,000	1,087,000	1,154,000
Average for driest 6 months,	574,000	384,000	502,060	532,000	230,000	143,000	330,000	211,000	145,000	200,000	391,000	223,000	234,000

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* The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878 inclusive, and subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894 and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

TABLE No. 7. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile* from 1875 to 1898* — Concluded.

MONTH.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	Mean for 24 years, 1875-98.
January,	1,053,000	2,782,000	1,254,000	3,018,000	1,870,000	434,000	693,000	1,034,000	1,084,000	845,000	1,638,000	1,209,000
February,	1,950,000	1,196,000	1,529,000	3,486,000	943,000	1,542,000	991,000	541,000	2,676,000	1,067,000	3,022,000	1,897,000
March,	3,238,000	1,338,000	3,643,000	4,453,000	1,955,000	3,245,000	2,238,000	2,410,000	3,835,000	2,565,000	2,604,000	2,847,000
April,	2,645,000	1,410,000	1,875,000	2,397,000	871,000	2,125,000	1,640,000	2,515,000	1,494,000	1,515,000	1,829,000	1,998,000
May,	1,632,000	880,000	1,366,000	583,000	1,259,000	2,883,000	840,000	636,000	360,000	915,000	1,246,000	1,110,000
June,	421,000	653,000	568,000	413,000	428,000	440,000	419,000	174,000	399,000	962,000	530,000	492,000
July,	117,000	634,000	107,000	149,000	214,000	158,000	161,000	231,000	95,000	658,000	231,000	205,000
August,	379,000	1,432,000	132,000	163,000	280,000	181,000	209,000	229,000	57,000	591,000	1,107,000	323,000
September,	1,155,000	823,000	457,000	203,000	229,000	108,000	150,000	89,000	388,000	182,000	369,000	249,000
October,	1,999,000	1,230,000	2,272,000	210,000	126,000	222,000	374,000	1,379,000	592,000	94,000	1,160,000	553,000
November,	2,758,000	1,941,000	1,215,000	305,000	697,000	319,000	836,000	2,777,000	659,000	909,000	1,986,000	980,000
December,	3,043,000	2,241,000	996,000	554,000	485,000	796,000	716,000	1,782,000	657,000	1,584,000	1,799,000	1,076,000
Average for year,	1,697,000	1,383,000	1,285,000	1,315,000	781,000	1,037,000	770,000	1,152,000	1,019,000	991,000	1,450,000	1,074,000
Average for driest 6 months,	953,000	944,000	747,000	239,000	327,000	237,000	356,000	460,000	314,000	564,000	777,000	465,000

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* The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878 inclusive, and subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894 and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

TABLE No. 8. — *Sudbury River. — Statistics of Flow of Water, Storage and Rainfall in 1898.*

[Watershed from 1875 to 1878 inclusive = 77.764 square miles; in 1879 and 1880 = 78.238 square miles; and from 1881 to 1898 inclusive = 75.2 square miles.]

MONTH.	Quantity of Water received through Wachusett Aqueduct (Gallons per Day).	Quantity of Water discharged through Sudbury Aqueduct (Gallons per Day).	Quantity of Water used by Framingham Water Company (Gallons per Day).	Quantity of Water wasted into River below Lowest Dam (Gallons per Day).	STORAGE.		Total Flow of River (Gallons per Day).	Rainfall (Inches).	Rainfall collected (Inches).	Percentage of Rainfall collected.
					Gain (Gallons per Day).	Loss (Gallons per Day).				
January, . . .	-	57,739,000	345,000	15,768,000	49,342,000	-	123,194,000	6.83	2.922	42.8
February, . . .	-	81,150,000	329,000	172,457,000	-	26,679,000	227,257,000	4.49	4.869	108.4
March, . . .	87,148,000	77,600,000	313,000	90,442,000	114,619,000	-	195,826,000	2.40	4.645	193.5
April, . . .	99,210,000	70,157,000	328,000	130,533,000	35,770,000	-	137,578,000	4.66	3.158	67.8
May, ...	53,423,000	67,894,000	345,000	64,026,000	14,823,000	-	93,665,000	3.22	2.222	69.0
June, ...	47,437,000	72,567,000	377,000	30,540,000	-	16,170,000	39,877,000	2.48	0.915	36.9
July, ...	24,629,000	77,464,000	423,000	13,671,000	-	49,584,000	17,345,000	4.09	0.411	10.1
August, . . .	6,000	76,142,000	348,000	62,106,000	-	55,364,000	83,226,000	8.17	1.974	24.2
September, . .	53,880,000	68,953,000	360,000	20,197,000	-	7,893,000	27,737,000	2.62	0.637	24.3
October, . . .	14,844,000	60,819,000	332,000	54,048,000	-	13,113,000	87,242,000	6.71	2.069	30.8
November, . .	12,927,000	65,397,000	310,000	100,150,000	-	3,550,000	149,380,000	6.93	3.429	49.5
December, . .	89,803,000	69,597,000	319,000	102,877,000	52,271,000	-	135,261,000	3.28	3.208	97.8
Totals, . .	-	-	-	-	-	-	-	55.88	30.459	-
Average for year,	40,464,000	70,382,000	344,000	70,582,000	8,221,000	-	109,065,000	-	-	54.5

Table No. 9. — *Lake Cochituate. — Statistics of Flow of Water, Storage and Rainfall in 1898.*

[Watershed of lake = 18.87* square miles.]

MONTH.	Quantity of Water received through the Sudbury Aqueduct (Gallons per Day).	Quantity of Water discharged through the Cochituate Aqueduct (Gallons per Day).	Quantity of Water wasted at Outlet (Gallons per Day).	Storage.		Quantity of Water collected in Lake (Gallons per Day).	Rainfall (Inches).	Rainfall collected (Inches).	Percentage of Rainfall collected.
				Gain (Gallons per Day).	Loss (Gallons per Day).				
January,	-	15,223,000	-	8,819,000	-	24,042,000	6.83	2.27	33.3
February,	-	4,725,000	28,861,000	13,910,000	-	47,496,000	4.29	4.06	94.5
March,	-	3,000,000	26,152,000	3,774,000	-	32,926,000	2.54	3.11	122.5
April,	70,000	570,000	28,677,000	260,000	-	29,437,000	5.07	2.69	53.1
May,	42,000	-	19,074,000	668,000	-	19,700,000	3.07	1.86	60.7
June,	73,000	-	8,866,000	-	260,000	8,533,000	2.08	0.78	37.5
July,	32,000	2,009,000	1,771,000	168,000	-	3,916,000	3.55	0.37	10.4
August,	32,000	2,239,000	11,558,000	-	-	13,765,000	7.08	1.30	18.4
September,	-	9,747,000	2,226,000	-	8,610,000	3,363,000	3.03	0.31	10.2
October,	-	13,987,000	-	3,000,000	-	16,987,000	6.82	1.61	23.5
November,	-	3,023,000	21,010,000	1,244,000	-	25,277,000	6.91	2.31	33.5
December,	-	-	32,648,000	-	3,661,000	28,987,000	3.44	2.74	79.7
Totals,	-	-	-	-	-	-	54.71	23.41	-
Average for year,	21,000	4,555,000	14,956,000	1,546,000	-	21,036,000	-	-	42.8

* Not including the watershed of Dudley Pond. No water was drawn from this pond during 1898.

TABLE No. 10. — *Spot Pond. — Statistics of Flow of Water and Storage in 1898.*

[Watershed of pond = 2.06 square miles.*]

In the case of this source of supply it was impracticable to measure the quantity of water collected in the pond from its own watershed, and the quantity collected has therefore been estimated upon the basis of the flow of other watersheds, after making proper corrections for rainfall upon and evaporation from water surfaces.

MONTH.	Estimated Quantity of Water collected in Pond (Gallons per Day).	Quantity of Water wasted from Pond (Gallons per Day).	STORAGE.		Quantity of Water gained in Pond by Pumping (Gallons per Day).	Quantity of Water drawn from Pond and used† (Gallons per Day).
			Gain (Gallons per Day).	Loss (Gallons per Day).		
January, . . .	2,752,000	-	1,459,000	-	-	1,293,000
February, . . .	5,077,000	-	10,307,000	-	5,230,000	-
March, . . .	4,375,000	-	6,623,000	-	2,248,000	-
April, . . .	3,073,000	-	4,855,000	-	1,782,000	-
May, ...	2,125,000	-	129,000	-	-	1,996,000
June, ...	168,000	-	-	2,490,000	-	2,658,000
July, ...	252,000	-	63,000	-	-	189,000
August, . . .	2,186,000	-	657,000	-	-	1,529,000
September, . .	131,000	-	-	873,000	-	1,004,000
October, . . .	2,780,000	-	2,180,000	-	-	600,000
November, . .	3,382,000	853,000	-	-	-	2,529,000
December, . .	3,022,000	1,055,000	-	8,118,000	-	10,085,000
Average for year,	2,430,000	160,000	1,167,000	-	-	1,103,000

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* 1.59 square miles land surface and 0.47 square miles water surface.

† Quantity of water collected from watershed $\left\{\begin{matrix}+\text{loss}\\-\text{gain}\end{matrix}\right\}$ in storage, less quantity wasted from pond.

TABLE No. 11. — *Elevations of Water Surfaces of Reservoirs above Boston City Base at the Beginning of Each Month.*

DATE	Chestnut Hill Reservoir. Ordinary High Water =134.00.	Lake Cochituate. High Water =144.36.	Spot Pond.	Farm Pond. High Water =159.25.	FRAMINGHAM RESERVOIR			Ashland Reservoir. Flash Boards 225.23.	Sudbury Reservoir. Crest of Dam 259.00.	Hopkinton Reservoir. Flash Boards 305.00.	Whitehall Reservoir. High Water =337.91.
					No. 1. Flash Boards 169.27.	No. 2. Flash Boards 177.12.	No. 3. Flash Boards 186.50.				
Jan. 1, 1898, .	134.24	140.87	144.96	158.75	167.28	176.05	184.78	220.08	244.41	304.20	336.48
Feb. 1, 1898, .	133.48	142.12	145.87	159.34	168.02	176.02	185.90	224.53	248.22	304.35	337.56
March 1, 1898, .	133.67	143.78	150.67	159.62	168.32	176.38	185.59	224.68	244.80	304.54	337.89
April 1, 1898, .	134.22	144.24	153.08	159.65	167.90	176.12	185.40	224.58	256.54	304.34	336.97
May 1, 1898, .	133.18	144.27	154.55	159.43	168.06	176.30	185.25	224.65	258.70	304.45	337.94
June 1, 1898, .	133.91	144.35	154.59	159.44	169.62	177.34	186.20	225.15	259.05	304.91	338.26
July 1, 1898, .	133.84	144.32	153.83	159.16	169.38	177.50	186.41	225.25	257.74	304.78	338.57
Aug. 1, 1898, .	133.76	144.34	153.85	158.98	169.38	177.53	186.41	225.26	253.90	304.84	338.58
Sept. 1, 1898, .	133.95	144.34	154.06	159.22	169.47	177.62	185.95	225.28	249.32	305.04	337.94
Oct. 1, 1898, .	133.63	143.31	153.79	158.92	168.78	177.57	186.01	225.25	248.65	305.02	337.96
Nov. 1, 1898, .	133.88	143.69	154.48	159.23	169.57	177.79	185.41	225.15	247.38	305.13	337.55
Dec. 1, 1898, .	133.61	143.84	154.48	159.13	168.05	177.29	185.74	224.67	247.57	304.48	337.45
Jan. 1, 1899, .	133.84	143.38	151.78	159.42	167.97	176.20	185.00	224.55	253.39	304.12	336.78

TABLE No. 12. — *Times when the Sudbury and Cochituate Aqueducts have been in Service, and the Sources from which the Supply for the Sudbury Aqueduct has been drawn.*

Sudbury Aqueduct: —

From 7 A.M. Jan. 1 to 11 A.M. Jan. 1, from Framingham Reservoirs Nos. 2, 3.
From 12 M. Jan. 1 to 11 A.M. Jan. 3, from Framingham Reservoirs Nos. 1, 2.
From 11 A.M. Jan. 3 to 11 A M. Jan. 7, from Framingham Reservoirs Nos. 1, 2, 3.
From 11. A.M. Jan. 7 to 11 A.M. Jan. 13, from Framingham Reservoirs Nos. 1, 2.
From 11 A.M. Jan. 13 to 11 A.M. Jan. 14, from Framingham Reservoirs Nos. 1, 2, 3.
From 11 A.M. Jan. 14 to 11 A.M. Jan. 15, from Framingham Reservoirs Nos. 2, 3.
From 12 M. Jan. 15 to 12 M. Jan. 18, from Framingham Reservoirs Nos. 1, 2.
From 12 M. Jan. 18 to 1 P.M. Jan. 18, from Framingham Reservoir No. 2.
From 1 P.M. Jan. 18 to 12 M. Jan. 19, from Framingham Reservoirs Nos. 1, 2.
From 12 M. Jan. 19 to 1.30 P.M. Jan. 21, from Framingham Reservoirs Nos. 1, 2, 3.
From 1.30 P.M. Jan. 21 to 11 A M. Jan. 25, from Framingham Reservoirs Nos. 2, 3.
From 11 A.M. Jan 25 to 11.15 A.M. Feb. 5, from Framingham Reservoirs Nos. 1, 2.
From 11.45 A.M. Feb. 5 to 2 P.M. April 16, from Framingham Reservoirs Nos. 1, 2.
From 2 P.M. April 16 to 6 P.M. April 19, from Framingham Reservoirs Nos. 2, 3.
From 8 P.M. April 20 to 6 P.M. April 28, from Framingham Reservoir No. 3
From 8 P.M April 29 to 6 P.M. May 9, from Framingham Reservoir No. 3.
From 8 P.M. May 10 to 6 P.M. May 24, from Framingham Reservoir No. 3.
From 8 P.M. May 25 to 6 P.M. May 31, from Framingham Reservoir No. 3.
From 8 P.M. June 1 to 6 P.M. June 7, from Framingham Reservoir No. 3.
From 8 P.M. June 8 to 6 P.M. June 21, from Framingham Reservoir No. 3.
From 8 P.M. June 22 to 6 P.M. July 18, from Framingham Reservoir No. 3.
From 8 P.M. July 19 to 6 P.M. Aug. 10, from Framingham Reservoir No. 3.
From 8 P.M. Aug. 11 to 7 A.M. Oct. 24, from Framingham Reservoir No. 3.
From 11 A.M. Oct. 24 to 7 A.M. Oct. 27, from Framingham Reservoir No. 3.
From 10 A.M. Oct. 27 to 12 M. Nov 11, from Framingham Reservoir No. 3.
From 2.45 P.M. Nov. 11 to 10 P.M. Dec. 27, from Framingham Reservoir No. 3.
From 10 A.M. Dec. 28 to 7 A.M. Jan. 1, 1899, from Framingham Reservoir No. 3.

Cochituate Aqueduct: —

From 7 A.M. Jan. 1 to 2 P.M. Jan. 31.
From 5 P.M. Feb. 1 to 11 A.M. Feb. 22.
From 7 P.M. March 1 to 7 A.M. March 21.
From 7 A.M. March 22 to 10 A.M. March 23.
From 5 A.M. April 6 to 10 A M. April 8.
From 7 A.M. July 16 to 11 A.M. July 22.
From 7 A.M. Aug 4 to 12 M. Aug. 8.
From 7 A.M. Aug. 10 to 11 A.M. Aug. 11.
From 11 A.M. Sept. 10 to 2 P.M. Nov. 7.

TABLE No. 13. — *Water supplied from Local Sources.*

MONTH.	Malden* (Million Gallons).	Medford† (Million Gallons).	Quincy‡ (Million Gallons).	Watertown and Belmont§ (Million Gallons).	Revere and Winthrop‖ (Million Gallons).	Total (Million Gallons).	Gallons Per Day.
January, .	32.35	30.87	38.24	14.73	33.54	149.73	4,830,000
February, .	–	28.44	36.11	12.45	21.61	98.61	3,522,000
March, . .	2.86	28.63	38.95	12.94	18.24	101.62	3,278,000
April, . .	2.24	28.57	37.39	13.01	20.02	101.23	3,374,000
May, . .	.10	32.52	38.43	14.98	20.49	106.52	3,436,000
June, . .	–	14.03	42.09	16.13	19.71	91.96	3,065,000
July, . .	–	–	50.21	18.34	17.12	85.67	2,763,000
August, . .	1.92	–	44.52	16.44	19.45	82.33	2,656,000
September, .	3.11	–	46.81	17.44	18.40	85.76	2,859,000
October, .	1.59	–	44.99	17.63	17.04	81.25	2,621,000
November, .	–	4.93	41.18	16.02	20.64	82.77	2,759,000
December, .	–	33.99	41.00	–	23.17	98.16	3,166,000
Totals, .	44.17	201.98	499.92	170.11	249.43	1,165.61	3,193,000

* Malden supply from Eaton's Wells.
† Medford supply from Wright's Pond and reservoir on west arm of brook.
‡ Quincy supply from local sources discontinued on December 31, 1898.
§ Watertown and Belmont supply from local sources discontinued on November 30, 1898.
‖ Revere supply from Saugus and Revere wells until February 9, 1898, and from Saugus wells thereafter.

TABLE No. 14. — *Average Daily Quantity of Water flowing through Aqueducts in 1898, by Months.*

MONTH.	Wachusett Aqueduct (Gallons).	SUDBURY AQUEDUCT.			Cochituate Aqueduct (Gallons).
		From Framingham Reservoir No. 3 (Gallons).	From Framingham Reservoirs Nos. 1 and 2 (Gallons).	Total (Gallons).	
January, . .	–	7,281,000	50,458,000	57,739,000	15,223,000
February, . .	–	–	81,150,000	81,150,000	4,725,000
March, . . .	87,148,000	–	77,600,000	77,600,000	3,000,000
April, . . .	99,210,000	26,734,000	43,423,000	70,157,000	570,000
May, . . .	53,423,000	67,894,000	–	67,894,000	–
June, . . .	47,437,000	72,567,000	–	72,567,000	–
July, . . .	24,629,000	77,464,000	–	77,464,000	2,009,000
August, . .	6,000	76,142,000	–	76,142,000	2,239,000
September, . .	53,880,000	68,953,000	–	68,953,000	9,747,000
October, . .	14,844,000	60,819,000	–	60,819,000	13,987,000
November, . .	12,927,000	65,397,000	–	65,397,000	3,023,000
December, . .	89,803,000	69,597,000	–	69,597,000	–
Averages, .	40,464,000	49,711,000	20,671,000	70,382,000	4,555,000

The Wachusett Aqueduct discharges into Sudbury Reservoir, whence the water flows into Framingham Reservoir No. 3. Of the total quantity flowing through the Sudbury Aqueduct, an average of 21,000 gallons per day flowed into Lake Cochituate, leaving an average of 70,361,000 gallons per day which was discharged into Chestnut Hill Reservoir.

TABLE NO. 15. — *Statement of Operations of Engines Nos. 1 and 2 at Chestnut Hill Pumping Station for the Year 1898.*

[These engines were designed for high-service engines, but were used during 1898 for low-service duty except on October 24 and 25, when 21,000,000 gallons were pumped to the high-service.]

1898. MONTH.	Engine No. 1.		Engine No. 2.											
	Total Pumping Time.	Amount pumped, 4 Per Cent. being allowed for Slip (Million Gallons).	Total Pumping Time.	Amount pumped, 4 Per Cent. being allowed for Slip (Million Gallons).	Total Amount pumped (Million Gallons).	Daily Average Amount pumped (Million Gallons).	Total Amount of Coal consumed (Pounds).	Daily Average Amount of Coal consumed (Pounds).	Total Amount of Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers.	Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons).	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting, 4 Per Cent. being allowed for Slip.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting.
	Hrs. Min.		Hrs. Min.											
January, . .	602 55	231.56	568 05	218.13	449.69	14.506	234,619	7,568	20,505	8.7	1,917	38.75	61,940,000	64,680,000
February, . .	631 55	274.73	652 20	287.45	562.18	20.078	319,167	11,398	28,880	9.0	1,761	44.48	65,340,000	68,230,000
March, . .	698 30	288.47	620 55	259.17	547.64	17.666	314,659	10,150	28,826	9.2	1,740	43.47	63,100,000	65,880,000
April, . .	636 00	267.96	621 45	266.22	534.18	17.806	291,612	9,720	28,104	9.6	1,832	39.67	60,610,000	63,280,000
May, . .	697 05	246.86	698 40	297.40	544.26	17.557	287,909	9,287	26,458	9.2	1,890	36.75	57,940,000	60,490,000
June, . .	663 50	271.33*	675 10	279.13*	550.46*	18.349	329,075	10,969	30,791	9.4	1,673	39.37	54,920,000*	62,330,000
July, . .	716 45	313.87*	729 40	321.10*	634.97*	20.483	450,681	14,536	41,388	9.2	1,409	48.26	56,710,000*	65,800,000
August, . .	692 55	324.63	736 15	342.27	666.90	21.512	399,597	12,890	21,964	5.5	1,669	45.09	62,760,000	65,530,000
September, . .	713 10	354.75	690 20	345.98	700.73	23.358	450,503	15,017	25,637	5.7	1,555	47.70	61,880,000	64,610,000
October, . .	693 30	329.48	721 00	344.47	673.95	21.740	426,138	13,746	26,512	6.2	1,582	50.05	66,020,000	68,930,000
November, . .	625 10	245.81	715 45	283.68	529.49	17.650	281,227	9,374	17,003	6.0	1,883	37.28	58,540,000	61,120,000
December, . .	573 28	145.01	657 40	257.43	402.44	12.982	192,182	6,198	10,741	5.6	2,095	27.58	48,180,000	50,310,000
Totals and Averages, . .	7,650 13	3,294.46	8,087 35	3,502.43	6,796.89	18.622	3,977,254	10,897	306,754	7.7	1,709	41.54	59,210,000	62,900,000

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* 8 per cent. for June and 10 per cent. for July deducted for defective valves, in addition to the regular 4 per cent. allowance for slip.

TABLE NO. 16. — *Statement of Operations of Engines Nos. 3 and 4 at Chestnut Hill Pumping Station for the Year 1898.*

1898. MONTH.	ENGINE NO. 3.											SUMMARY, ENGINES NOS. 1, 2, 3 AND 4.	
	Total Pumping Time.	Amount pumped, 3 Per Cent. being allowed for Slip (Million Gallons).	Daily Average Amount pumped, 3 Per Cent. being allowed for Slip (Million Gallons).	Amount of Coal consumed (Pounds).	Daily Average Amount of Coal consumed (Pounds).	Amount of Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers.	Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons).	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting, 3 Per Cent. being allowed for Slip.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting.	Total Amount pumped, Allowances made for Slip (Million Gallons).	Daily Average Amount pumped (Million Gallons).
	Hrs. Min.												
January,	738 35	480.01	15.484	445,377	14,367	38,542	8.6	1,078	124.88	112,250,000	115,750,000	929.70	29.990
February,	663 00	499.48*	17.838	469,705	16,775	37,570	8.0	1,063	125.31	111,130,000	114,600,000	1,061.66	37.916
March,	691 35	521.93*	16.836	524,154	17,472	42,412	8.9	996	126.60	105,140,000†	108,420,000	1,069.57	34.502
April,	707 00	467.89	15.596	471,756	15,725	37,510	8.0	992	125.34	103,680,000†	106,910,000	1,002.07	33.402
May,	728 20	521.48	16.822	487,428	15,723	40,258	8.3	1,070	125.93	112,360,000	115,870,000	1,065.74	34.379
June,	711 40	526.54	17.551	461,662	15,389	39,783	8.6	1,141	127.44	121,220,000	125,010,000	1,077.00	35.900
July,	740 15	625.88*	20.190	547,797	17,671	43,449	7.9	1,143	128.61	122,550,000	126,380,000	1,260.85	40.673
August,	734 20	569.15*	18.360	500,596	16,148	29,563	5.9	1,137	128.27	121,630,000	125,420,000	1,236.05	39.872
September,	715 25	571.88	19.063	500,440	16,681	29,390	5.9	1,143	129.75	123,660,000	127,520,000	1,272.61	42.421
October,	703 40	558.51	18.017	498,058	16,066	29,085	5.8	1,121	129.83	121,420,000	125,210,000	1,232.46	39.757
November,	715 50	531.67	17.722	495,817	16,527	29,839	6.0	1,072	128.07	114,530,000	118,110,000	1,061.16	35.372
December,	692 55	530.28	17.106	498,271	16,073	27,877	5.6	1,064	121.68	108,000,000	111,380,000	969.60	31.277
Totals and averages,	8,542 35	6,404.70	17.547	5,901,061	16,167	425,278	7.2	1,085	126.81	114,790,000	118,370,000	13,238.47	36.270
ENGINE NO. 4.													
December,	42.09	36.88‡	1.190‡	39,941	1,288	2,052	5.1	923‡	119.23§	-	91,820,000	-	-

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* In February, March, July and August, a total of 161,020,000 gallons was diverted through by-pass to low-service.

† Economizer out of commission and steam pipes partly uncovered during erection of Boiler No. 4.

‡ No slip allowed.

§ Readings of Engine No. 3 used to obtain this figure.

TABLE NO. 17. — *Statement of Operations at Melrose Pumping Station for the Year 1898.*

1898. MONTH.	Total Pumping Time.		Total Amount pumped, 3 Per Cent. being allowed for Slip (Million Gallons).	Daily Average Amount pumped (Million Gallons).	Coal consumed while pumping (Pounds).	Coal consumed for Banking Fires (Pounds).	Total Coal consumed (Pounds).	Daily Average Amount of Coal consumed (Pounds).	Total Amount of Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers.	Quantity pumped per Pound of Total Coal (Gallons).	Quantity pumped per Pound of Coal, deducting Coal for Banking (Gallons).	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Total Coal, 3 Per Cent. being allowed for Slip.	Duty in Foot-pounds per 100 Pounds of Total Coal, Basis of Plunger Displacement.
	Hrs.	Min.													
January, ...	370	30	32.29	1.042	64,130	9,300	73,430	2,369	8,974	12.2	440	504	-*	-*	-*
February, ...	310	05	27.50	0.982	53,300	8,400	61,700	2,204	7,403	12.0	446	516	126.4	47,000,000	48,400,000
March, ...	316	45	28.06	0.905	50,635	9,300	59,935	1,933	6,708	11.2	468	554	122.9	48,000,000	49,500,000
April, ...	295	10	26.83	0.894	46,350	9,000	55,350	1,845	5,595	10.1	485	579	121.8	49,200,000	50,800,000
May, ...	327	45	29.97	0.967	52,425	9,300	61,725	1,991	6,464	10.5	486	572	120.9	48,900,000	50,500,000
June, ...	358	50	34.17	1.139	58,550	9,000	67,550	2,252	7,324	10.8	506	584	121.2	51,100,000	52,700,000
July, ...	399	45	38.71	1.249	67,150	9,300	76,450	2,466	7,707	10.1	506	577	121.9	51,500,000	53,100,000
August, ...	345	25	32.90	1.061	57,150	9,300	66,450	2,144	6,039	9.1	495	576	121.9	50,300,000	51,900,000
September, ...	336	25	31.50	1.050	56,300	9,000	65,300	2,177	7,391	11.3	482	560	122.0	49,100,000	50,600,000
October, ...	309	00	29.45	0.950	52,350	9,300	61,650	1,989	6,011	9.8	478	563	122.0	48,600,000	50,100,000
November, ...	277	00	26.62	0.887	47,400	9,000	56,400	1,880	5,838	10.4	472	562	122.0	48,000,000	49,500,000
December, ...	308	15	30.06	0.970	54,450	9,300	63,750	2,056	7,421	11.6	472	552	124.0	48,800,000	50,300,000
Totals and averages, . .	3,954	55	368.06	1.008	660,190	109,500	769,690	2,109	82,875	10.8	478	558	122.5	48,900,000	50,400,000

* No data given for this month.

Table No. 18. — *Average Daily Consumption of Water in Cities and Towns in the Metropolitan Water District supplied Wholly or in Part by the Metropolitan Works.*

MONTH.	Supplied by Metropolitan Works (Million Gallons).	Supplied from Local Sources (Million Gallons).	Total (Million Gallons).	Estimated Population.	Consumption per Capita (Gallons).
January, ...	75.549	4.830	80.379	757,400	106
February, ...	80.260	3.522	83.782	759,200	110
March, ...	78.541	3.278	81.819	761,000	108
April, ...	69.401	3.374	72.775	762,900	95
May, ...	68.758	3.436	72.194	764,700	94
June, ...	75.312	3.065	78.377	766,600	102
July, ...	79.641	2.763	82.404	768,500	107
August, ...	79.653	2.656	82.309	770,500	107
September, ...	80.401	2.859	83.260	772,400	108
October, ...	74.881	2.621	77.502	774,300	100
November, ...	71.438	2.759	74.197	776,200	96
December, ...	79.289	3.166	82.455	778,100	106
For the year, ...	76.081	3.193	79.274	767,700	103

Table No. 19. — *Average Daily Consumption of Water from the Low-service.*

MONTH.	BOSTON.	SOMERVILLE, CHELSEA, EVERETT, MALDEN, MEDFORD,* CHARLESTOWN AND EAST BOSTON.†			Total Low-service Consumption (Million Gallons).
	Gravity Supply from Chestnut Hill Reservoir (Million Gallons).	Pumped at Chestnut Hill Reservoir (Million Gallons).	Gravity Supply from Spot Pond (Million Gallons).	Gravity Supply to Medford from Wright's Pond (Million Gallons).	
January, . . .	44.101	13.104	.251	.602	58.058
February, . . .	47.441	12.629	-	.623	60.693
March, ...	46.022	12.237	-	.573	59.832
April, ...	†37.865	†13.004	-	.611	51.480
May, ...	32.431	15.277	1.029	.675	49.412
June, ...	36.706	15.694	1.262	.307	53.969
July, ...	38.899	18.566	-	-	57.465
August, . . .	38.212	19.398	.034	-	57.644
September, . . .	36.969	20.008	-	-	56.977
October, . . .	34.534	17.718	-	-	52.252
November, . . .	33.445	15.352	1.270	.081	50.148
December, . . .	37.961	10.275	9.115	.616	57.967
For the year, . .	38.670	16.464	-	.340	55.474

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* Medford low-service drawn partly from Wright's Pond and partly from Metropolitan Water Works.

† Until April 21, the East Boston supply was drawn from Chestnut Hill reservoir, and after that date from Spot Pond service.

TABLE NO. 8. — *Sudbury River. — Statistics of Flow of Water, Storage and Rainfall in 1898.*

[Watershed from 1875 to 1878 inclusive = 77.764 square miles; in 1879 and 1880 = 78.238 square miles; and from 1881 to 1898 inclusive = 75.2 square miles.]

MONTH.	Quantity of Water received through Wachusett Aqueduct (Gallons per Day).	Quantity of Water discharged through Sudbury Aqueduct (Gallons per Day).	Quantity of Water used by Framingham Water Company (Gallons per Day).	Quantity of Water wasted into River below Lowest Dam (Gallons per Day).	STORAGE.		Total Flow of River (Gallons per Day).	Rainfall (Inches).	Rainfall collected (Inches).	Percentage of Rainfall collected.
					Gain (Gallons per Day).	Loss (Gallons per Day).				
January, ...	-	57,739,000	345,000	15,768,000	49,342,000	-	123,194,000	6.83	2.922	42.8
February, ...	-	81,150,000	329,000	172,457,000	-	26,679,000	227,257,000	4.49	4.869	108.4
March, . . .	87,148,000	77,600,000	313,000	90,442,000	114,619,000	-	195,826,000	2.40	4.645	193.5
April, . . .	99,210,000	70,157,000	323,000	130,533,000	35,770,000	-	137,573,000	4.66	3.158	67.8
May, ...	53,423,000	67,894,000	345,000	64,026,000	14,823,000	-	93,665,000	3.22	2.222	69.0
June, ...	47,437,000	72,567,000	377,000	30,540,000	-	16,170,000	39,877,000	2.48	0.915	36.9
July, ...	24,629,000	77,464,000	423,000	13,671,000	-	49,584,000	17,345,000	4.09	0.411	10.1
August, . . .	6,000	76,142,000	348,000	62,106,000	-	55,364,000	83,226,000	8.17	1.974	24.2
September, . .	53,880,000	68,953,000	360,000	20,197,000	-	7,893,000	27,737,000	2.62	0.637	24.3
October, . . .	14,844,000	60,819,000	332,000	54,048,000	-	13,113,000	87,242,000	6.71	2.069	30.8
November, . .	12,927,000	65,397,000	310,000	100,150,000	-	3,550,000	149,380,000	6.93	3.429	49.5
December, . .	89,803,000	69,597,000	319,000	102,877,000	52,271,000	-	135,261,000	3.28	3.208	97.8
Totals, . .	-	-	-	-	-	-	-	55.88	30.459	-
Average for year,	40,464,000	70,382,000	344,000	70,582,000	8,221,000	-	109,065,000	-	-	54.5

TABLE No. 9. — *Lake Cochituate. — Statistics of Flow of Water, Storage and Rainfall in 1898.*

[Watershed of lake = 18.87* square miles.]

MONTH.	Quantity of Water received through the Sudbury Aqueduct (Gallons per Day).	Quantity of Water discharged through the Cochituate Aqueduct (Gallons per Day).	Quantity of Water wasted at Outlet (Gallons per Day).	STORAGE.		Quantity of Water collected in Lake (Gallons per Day).	Rainfall (Inches).	Rainfall collected (Inches).	Percentage of Rainfall collected.
				Gain (Gallons per Day).	Loss (Gallons per Day).				
January,	-	15,223,000	-	8,819,000	-	24,042,000	6.83	2.27	33.3
February,	-	4,725,000	23,861,000	18,910,000	-	47,496,000	4.29	4.06	94.6
March,	-	3,000,000	26,152,000	3,774,000	-	32,926,000	2.54	3.11	122.5
April,	70,000	570,000	28,677,000	260,000	-	29,437,000	5.07	2.69	53.1
May,	42,000	-	19,074,000	668,000	-	19,700,000	3.07	1.86	60.7
June,	73,000	-	8,866,000	-	260,000	8,533,000	2.08	0.78	37.5
July,	32,000	2,009,000	1,771,000	168,000	-	3,916,000	3.55	0.37	10.4
August,	32,000	2,239,000	11,558,000	-	-	13,765,000	7.08	1.30	18.4
September,	-	9,747,000	2,226,000	-	8,610,000	3,363,000	3.03	0.31	10.2
October,	-	13,987,000	-	3,000,000	-	16,987,000	6.82	1.61	23.6
November,	-	3,023,000	21,010,000	1,244,000	-	25,277,000	6.91	2.31	33.5
December,	-	-	32,648,000	-	3,661,000	28,987,000	3.44	2.74	79.7
Totals,	-	-	-	-	-	-	54.71	23.41	-
Average for year,	21,000	4,555,000	14,986,000	1,546,000	-	21,086,000	-	-	42.8

* Not including the watershed of Dudley Pond. No water was drawn from this pond during 1898.

TABLE NO. 23. — *Chemical Examinations of Water from the Nashua River above the Temporary Dam at Clinton.*

[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.				ODOR.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen Consumed.	Hardness.
				COLOR.							ALBUMINOID.							
		Turbidity.	Sediment.	Nessler Standard.	Transformed to Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1898.																	
21743	Jan. 3	Distinct.	Cons.	.40	.39	Faintly vegetable.	Distinctly vegetable.	3.65	1.25	.0002	.0144	.0138	.0006	.25	.0130	.0001	.41	1.4
22041	Jan. 31	Slight.	Slight.	.41	.40	Faintly vegetable	Faintly vegetable.	3.25	1.25	.0016	.0152	.0126	.0026	.24	.0130	.0000	.42	1.3
22381	Feb. 28	Slight.	V. slight.	.45	.42	Faintly vegetable.	Faintly vegetable.	3.35	1.10	.0010	.0176	.0154	.0022	.21	.0080	.0000	.36	0.8
22710	Apr. 4	V. slight.	V. slight.	.35	.36	Faintly vegetable.	Distinctly vegetable.	2.75	1.45	.0002	.0116	.0104	.0012	.16	.0020	.0000	.40	0.6
23088	May 2	Slight.	V. slight.	.51	.47	Faintly vegetable.	Faintly vegetable.	2.70	1.05	.0002	.0164	.0152	.0012	.19	.0000	.0001	.42	1.0
23334	May 31	V. slight.	V. slight.	.76	.61	Faintly vegetable and musty.	Faintly vegetable and musty.	3.55	2.00	.0022	.0188	.0162	.0026	.16	.0040	.0001	.61	0.8
23785	July 1	Slight.	Cons.	.48	.45	Faintly vegetable	Faintly vegetable.	3.95	1.80	.0040	.0234	.0200	.0034	.20	.0050	.0001	.44	1.0
24125	Aug. 1	Slight.	V. slight.	.30	.33	None.	Distinctly fishy.	3.95	1.50	.0014	.0242	.0188	.0054	.21	.0020	.0000	.33	1.0
24508	Aug. 31	V. slight.	V. slight.	.70	.58	Faintly vegetable.	Faintly vegetable.	4.45	2.15	.0030	.0236	.0208	.0028	.18	.0060	.0001	.89	1.1
24896	Oct. 3	V. slight.	V. slight.	.45	.42	None.	None.	4.00	1.75	.0018	.0202	.0190	.0012	.20	.0010	.0000	.58	1.1
25215	Oct. 31	V. slight.	V. slight.	.65	.55	None.	Faintly vegetable.	3.75	1.75	.0000	.0154	.0148	.0006	.20	.0020	.0000	.78	1.0
25526	Dec. 1	V. slight.	V. slight.	.40	.39	Faintly vegetable.	Faintly vegetable.	3.00	1.40	.0006	.0128	.0108	.0020	.18	.0070	.0001	.52	1.0
Av....	....	....	....	.49	.45	....	....	3.53	1.54	.0013	.0178	.0156	.0022	.20	.0052	.0000	.51	1.0

TABLE No. 11. — *Elevations of Water Surfaces of Reservoirs above Boston City Base at the Beginning of Each Month.*

DATE	Chestnut Hill Reservoir. Ordinary High Water =134.00.	Lake Cochituate. High Water =144.36.	Spot Pond.	Farm Pond. High Water =159.25.	FRAMINGHAM RESERVOIR			Ashland Reservoir. Flash Boards 225.23.	Sudbury Reservoir. Crest of Dam 259.00.	Hopkinton Reservoir. Flash Boards 305.00.	Whitehall Reservoir. High Water =337.91.
					No. 1. Flash Boards 169.27.	No. 2. Flash Boards 177.12.	No. 3. Flash Boards 186.50.				
Jan. 1, 1898, .	134.24	140.87	144.96	158.75	167.28	176.05	184.78	220.08	244.41	304.20	336.48
Feb. 1, 1898, .	133.48	142.12	145.87	159.34	168.02	176.02	185.90	224.53	248.22	304.35	337.56
March 1, 1898, .	133.67	143.78	150.67	159.62	168.32	176.38	185.59	224.68	244.80	304.54	337.89
April 1, 1898, .	134.22	144.24	153.03	159.65	167.90	176.12	185.40	224.58	256.54	304.34	336.97
May 1, 1898, .	133.18	144.27	154.55	159.43	168.06	176.30	185.25	224.65	258.70	304.45	337.94
June 1, 1898, .	133.91	144.35	154.59	159.44	169.62	177.34	186.20	225.15	259.05	304.91	338.26
July 1, 1898, .	133.84	144.32	153.83	159.16	169.38	177.50	186.41	225.25	257.74	304.78	338.57
Aug. 1, 1898, .	133.76	144.34	153.85	158.98	169.38	177.53	186.41	225.26	253.90	304.84	338.58
Sept. 1, 1898, .	133.95	144.34	154.06	159.22	169.47	177.62	185.95	225.28	249.32	305.04	337.94
Oct. 1, 1898, .	133.63	143.31	153.79	158.92	168.78	177.57	186.01	225.25	248.65	305.02	337.96
Nov. 1, 1898, .	133.88	143.69	154.48	159.23	169.57	177.79	185.41	225.15	247.38	305.13	337.55
Dec. 1, 1898, .	133.61	143.84	154.48	159.13	168.05	177.29	185.74	224.67	247.57	304.48	337.45
Jan. 1, 1899, .	133.84	143.38	151.78	159.42	167.97	176.20	185.00	224.55	253.39	304.12	336.78

TABLE NO. 25. — *Chemical Examinations of Water from Lake Cochituate.*

[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.				ODOR.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen Consumed.	Hardness.
				COLOR.							ALBUMINOID.							
		Turbidity.	Sediment.	Nessler Standard.	Transformed to Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1898.																	
21739	Jan. 3	Slight.	Cons. cyclops.	.28	.32	Distinctly vegetable.	Strongly vegetable, cucumber.	5.30	1.90	.0016	.0198	.0176	.0022	.54	.0060	.0002	.40	2.7
22038	Jan. 31	V. slight.	Cons. cyclops.	.38	.38	Distinctly vegetable.	Strongly vegetable, strong cucumber.	5.10	1.75	.0028	.0196	.0178	.0018	.53	.0070	.0001	.47	2.3
22376	Feb. 28	Slight.	Cons. cyclops.	.48	.45	Faintly vegetable.	Strongly vegetable.	4.85	1.50	.0026	.0192	.0174	.0018	.39	.0100	.0002	.51	2.1
22720	Apr. 4	Slight.	Slight.	.32	.34	Faintly vegetable.	Distinctly cucumber.	5.05	1.70	.0010	.0202	.0162	.0040	.47	.0120	.0000	.51	2.1
23031	May 2	V. slight.	Slight.	.38	.38	Distinctly vegetable.	Distinctly vegetable	5.05	1.65	.0006	.0190	.0176	.0014	.51	.0110	.0003	.44	2.0
23340	May 31	V. slight.	V. slight.	.42	.40	Distinctly vegetable.	Distinctly vegetable.	4.90	1.85	.0014	.0216	.0156	.0060	.50	.0090	.0002	.47	1.8
23773	June 30	Slight.	Slight	.29	.32	Faintly vegetable.	Distinctly vegetable.	4.70	1.85	.0016	.0208	.0182	.0026	.41	.0060	.0003	.50	2.1
24118	Aug. 1	V. slight.	Slight.	.22	.27	None.	Faintly vegetable.	4.75	1.70	.0010	.0192	.0174	.0018	.40	.0020	.0002	.39	1.8
24512	Sept. 1	V. slight.	Slight.	.19	.26	None.	Faintly vegetable.	4.95	2.15	.0026	.0290	.0232	.0058	.45	.0020	.0000	.40	1.7
24886	Oct. 3	V. slight.	Slight.	.19	.26	Faintly vegetable.	Distinctly vegetable, anabæna.	4.85	1.95	.0006	.0202	.0164	.0038	.45	.0000	.0000	.44	2.2
25213	Oct. 31	V. slight.	Slight cyclops.	.20	.26	None.	Distinctly vegetable and grassy.	4.70	1.65	.0000	.0168	.0136	.0032	.42	.0060	.0000	.43	2.0
25523	Dec. 1	V. slight.	Slight.	.30	.33	Faintly vegetable.	Distinctly vegetable and cucumber.	4.90	1.85	.0032	.0184	.0162	.0022	.54	.0080	.0002	.50	2.1
Av.	....	....	....	.30	.33	....	....	4.92	1.79	.0016	.0203	.0173	.0030	.47	.0066	.0001	.45	2.1

TABLE NO. 26. — *Chemical Examinations of Water from Spot Pond, Stoneham.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.				Odor.		Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
				Color.							Albuminoid.							
		Turbidity.	Sediment.	Nessler Standard	Transformed to Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1898.																	
21760	Jan. 4	Slight.	Slight.	.40	.39	Faintly musty.	Faintly musty.	6.00	2.10	.0050	.0284	.0262	.0022	.68	.0060	.0001	.52	2.9
22087	Feb. 7	Slight.	V. slight.	.48	.45	None.	None.	5.45	1.60	.0040	.0198	.0188	.0010	.61	.0070	.0001	.49	2.1
22344	Feb. 24	Slight.	Slight.	.60	.52	Faintly vegetable.	Faintly vegetable.	5.05	1.75	.0058	.0168	.0164	.0004	.54	.0100	.0000	.53	2.0
22707	Apr. 4	V. slight.	V. slight.	.45	.42	Distinctly vegetable.	Distinctly vegetable	4.65	1.80	.0022	.0214	.0184	.0030	.46	.0050	.0001	.50	1.8
23019	May 2	Slight.	Slight.	.50	.46	Faintly vegetable.	Distinctly vegetable.	4.50	1.50	.0010	.0226	.0194	.0032	.46	.0060	.0001	.50	1.7
23347	June 1	Slight.	Slight and cons. cyclops.	.57	.50	Distinctly vegetable.	Distinctly vegetable.	4.55	1.75	.0058	.0224	.0162	.0062	.46	.0040	.0002	.53	1.8
23761	June 30	Slight.	Slight.	.45	.42	Faintly vegetable.	Distinctly vegetable and grassy.	4.90	1.60	.0102	.0216	.0194	.0022	.50	.0010	.0002	.53	1.7
24117	Aug. 1	Decided.	Cons.	.58	.51	Faintly vegetable.	Faintly vegetable.	5.10	1.95	.0142	.0240	.0210	.0030	.40	.0020	.0002	.47	1.7
24499	Aug. 31	Decided.	Cons.	.40	.39	Distinctly musty and disagreeable.	Distinctly musty and disagreeable.	4.65	1.95	.0006	.0280	.0230	.0050	.37	.0000	.0000	.58	1.6
24881	Oct. 3	Decided.	Cons.	.39	.38	Distinctly musty and disagreeable.	Distinctly musty and disagreeable.	5.10	1.90	.0030	.0266	.0246	.0020	.36	.0000	.0000	.51	1.8
25205	Oct. 31	Decided	Slight, cyclops.	.31	.34	Distinctly musty.	Distinctly musty and disagreeable.	4.60	2.00	.0014	.0288	.0206	.0082	.37	.0010	.0000	.54	1.8
25508	Dec. 1	Slight.	Slight, also scum.	.40	.39	Faintly unpleasant.	Distinctly vegetable and unpleasant.	4.85	2.25	.0014	.0264	.0226	.0038	.37	.0020	.0000	.57	1.8
Av....	....	....	....	.46	.43	....	....	4.95	1.85	.0045	.0239	.0205	.0034	.46	.0028	.0001	.52	1.9

TABLE NO. 27. — *Chemical Examinations of Water from a Faucet at the State House, Boston.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.				Odor.		Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
				Color.							Albuminoid.							
		Turbidity.	Sediment.	Nessler Standard.	Transformed to Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1898.																	
21744	Jan. 4	V. slight.	Slight.	.61	.53	Faintly vegetable.	Distinctly vegetable.	4.75	2.10	.0010	.0204	.0172	.0032	.44	.0110	.0001	.58	2.1
22039	Feb. 1	Slight.	Slight, cyclops.	.60	.52	Faintly vegetable.	Distinctly vegetable, faint cucumber.	4.50	1.70	.0014	.0164	.0152	.0012	.43	.0150	.0000	.61	1.8
22377	Mar. 1	Slight.	Slight.	.60	.52	None.	Faintly vegetable.	3.80	1.35	.0024	.0134	.0128	.0006	.25	.0130	.0000	.47	1.1
22708	April 4	V. slight.	V. slight.	.68	.57	Faintly vegetable and musty.	Faintly vegetable and musty.	3.30	1.75	.0016	.0178	.0152	.0026	.30	.0070	.0000	.57	0.8
23051	May 4	V. slight.	Slight.	.40	.39	Distinctly vegetable.	Distinctly vegetable.	3.70	1.55	.0010	.0102	.0090	.0012	.24	0130	.0000	.32	1.1
23328	June 1	V. slight.	V. slight.	.40	.39	Distinctly vegetable.	Distinctly vegetable.	3.85	1.40	.0006	.0122	.0094	.0028	.28	.0190	.0000	.36	1.4
23760	June 30	V. slight.	Slight.	.30	.33	None.	Faintly vegetable.	4.15	1.05	.0004	.0134	.0130	.0004	.26	.0130	.0002	.34	1.3
24103	Aug. 1	Slight.	Slight.	.25	.29	None.	Faintly vegetable.	4.30	1.30	.0002	.0134	.0124	.0010	.22	.0080	.0001	.31	1.3
24490	Aug. 31	V. slight.	V. slight.	.22	.27	None.	Faintly vegetable.	3.75	1.45	.0002	.0166	.0136	.0030	.23	.0040	.0001	.38	1.4
24879	Oct. 3	Slight.	Slight.	.24	.29	None.	Faintly vegetable.	4.45	1.50	.0002	.0188	.0174	.0014	.31	.0040	.0001	.41	1.6
25204	Oct. 31	Slight.	Slight.	.30	.33	None.	Faintly vegetable.	4.90	1.90	.0000	.0152	.0150	.0002	.29	.0030	.0000	.43	1.7
25509	Dec. 1	Slight.	Slight.	.35	.36	Faintly vegetable.	Faintly vegetable.	4.85	2.20	.0010	.0146	.0126	.0020	.29	.0070	.0001	.45	1.8
Av...	....	....	....	.41	.40	....	....	4.19	1.60	.0008	.0152	.0136	.0016	.29	.0097	.0001	.44	1.4

TABLE No. 28. — *Averages of Monthly Examinations of Water from Various Parts of the Metropolitan Water Works — 1898.*

[Parts per 100,000.]

LOCALITY.	COLOR.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen Consumed.	Hardness.
						ALBUMINOID.							
	Nessler Standard.	Platinum Standard.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
Quinepoxet River, Holden,	.62	.53	3.47	1.55	.0030	.0248	.0215	.0033	.21	.0037	.0001	.60	0.8
Stillwater River, Sterling,	.51	.46	3.02	1.81	.0008	.0158	.0142	.0016	.16	.0026	.0001	.50	0.8
Nashua River, Clinton,	.49	.45	3.53	1.54	.0013	.0178	.0156	.0022	.20	.0052	.0000	.51	1.0
Walker's Brook, Marlborough,	.58	.51	14.53	4.43	.0569	.0230	.0206	.0024	1.71	.2068	.0046	.56	5.1
Sudbury Reservoir, surface,*	.39	.39	4.47	1.61	.0030	.0183	.0151	.0032	.28	.0115	.0002	.44	1.7
Sudbury Reservoir, mid-depth,*	.45	.42	4.98	1.84	.0049	.0173	.0153	.0021	.31	.0159	.0002	.47	1.9
Sudbury Reservoir, bottom,*	.45	.42	5.06	1.80	.0056	.0170	.0149	.0021	.31	.0182	.0002	.47	1.9
Framingham Reservoir No. 3, near dam,	.38	.38	4.54	1.56	.0018	.0182	.0157	.0025	.29	.0115	.0002	.45	1.6
Hopkinton Reservoir, influent,	1.51	1.17	5.81	3.12	.0012	.0318	.0300	.0018	.44	.0032	.0000	1.44	1.4
Hopkinton Reservoir, surface,	.62	.53	3.71	1.80	.0016	.0204	.0183	.0021	.35	.0030	.0000	.69	1.1
Hopkinton Reservoir, bottom,	.62	.53	3.74	1.70	.0022	.0168	.0156	.0012	.35	.0057	.0000	.65	1.0
Ashland Reservoir, influent,	1.24	.98	4.70	2.43	.0009	.0294	.0274	.0020	.31	.0035	.0000	1.10	1.2
Ashland Reservoir, surface,	.72	.60	3.76	1.85	.0008	.0221	.0205	.0016	.29	.0032	.0000	.75	1.0
Ashland Reservoir, bottom,	.69	.57	3.84	1.87	.0015	.0203	.0191	.0012	.29	.0037	.0001	.73	1.0
Framingham Reservoir No. 2, influent,	.96	.76	4.55	2.13	.0022	.0262	.0233	.0029	.31	.0057	.0000	.95	1.2
Framingham Reservoir No. 2, near dam,	.89	.72	4.47	2.19	.0022	.0241	.0220	.0021	.29	.0054	.0001	.93	1.1
Lake Cochituate,	.30	.33	4.92	1.79	.0016	.0203	.0173	.0030	.47	.0066	.0001	.45	2.1
Terminal chamber, Sudbury Aqueduct,†	.38	.38	4.24	1.68	.0019	.0162	.0133	.0029	.26	.0081	.0001	.44	1.4
Spot Pond,	.46	.43	4.95	1.85	.0045	.0239	.0205	.0034	.46	.0028	.0001	.52	1.9
Tap at State House,	.41	.40	4.19	1.60	.0008	.0152	.0136	.0016	.29	.0097	.0001	.44	1.4

* These examinations were made weekly after April 1.

† Nine months, beginning April 1.

TABLE No. 29. — *Chemical Examinations of Water from a Faucet in Boston, from 1888 to 1898.*

[Parts per 100,000.]

YEAR.	COLOR.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen Consumed.	Hardness.
						ALBUMINOID.							
	Nessler Standard	Platinum Standard.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1888, . .	.38	.38	4.94	1.53	.0012	.0215	-	-	.40	.0183	.0002	-	-
1889, . .	.51	.46	4.71	1.43	.0005	.0199	.0176	.0023	.42	.0272	.0002	-	-
1890, . .	.35	.36	4.70	1.25	.0003	.0169	.0148	.0021	.42	.0241	.0001	-	2.2
1891, . .	.37	.38	4.39	1.63	.0005	.0161	.0136	.0025	.37	.0227	.0001	-	1.7
1892, . .	.37	.37	4.70	1.67	.0007	.0168	.0138	.0030	.41	.0210	.0001	-	1.9
1893, . .	.61	.53	4.54	1.84	.0010	.0174	.0147	.0027	.38	.0143	.0001	.60	1.8
1894, . .	.69	.58	4.64	1.83	.0006	.0169	.0150	.0019	.41	.0106	.0001	.63	1.7
1895, . .	.72	.59	4.90	2.02	.0006	.0197	.0175	.0022	.40	.0171	.0001	.69	0.7
1896, . .	.49	.45	4.29	1.67	.0005	.0165	.0142	.0023	.37	.0155	.0001	.56	1.4
1897, . .	.65	.55	4.82	1.84	.0009	.0193	.0177	.0016	.40	.0137	.0001	.64	1.6
1898, . .	.41	.40	4.19	1.60	.0008	.0152	.0136	.0016	.29	.0097	.0001	.44	1.4

TABLE No. 30. — *Microscopical Examinations of Water from Various Parts of the Metropolitan Water Works, 1898.*

Nashua River at Head of Wachusett Aqueduct.

[Standard units per cubic centimeter.]

MONTH.	ORGANISMS.	AMORPHOUS.	Principal Organisms.
	Surface.	Surface.	
January, ...	-	-	- -
February, ...	-	-	- -
March, ...	-	-	- -
April, ...	164	131	Infusoria.
May, ...	130	156	Diatomaceæ. Infusoria.
June, ...	232	231	Diatomaceæ. Cyanophyceæ. Infusoria.
July, ...	266	218	Diatomaceæ. Chlorophyceæ. Infusoria.
August, ...	167	140	Clorophyceæ. Infusoria.
September, ...	142	138	Cyanophyceæ. Infusoria.
October, ...	96	144	Infusoria.
November, ...	81	114	Cyanophyceæ. Infusoria.
December, ...	17	102	- -
Mean, ...	144	153	

TABLE No. 30 — *Continued.*

Sudbury Reservoir, 1898.

[Standard units per cubic centimeter.]

MONTH.	Organisms.			Amorphous.			Principal Organisms.
	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth	Bottom.	
January, ...	74	80	91	144	354	195	Diatomaceæ.
February, ...	34	41	52	145	210	213	– –
March, ...	268	119	43	227	192	331	Infusoria.
April, ...	347	298	185	195	192	163	Infusoria. Diatomaceæ.
May, ...	432	244	160	118	112	122	Infusoria. Rotifera. Diatomaceæ.
June, ...	703	289	138	135	128	128	Diatomaceæ. Cyanophyceæ. Infusoria.
July, ...	597	186	119	128	141	197	Diatomaceæ. Cyanophyceæ.
August, ...	600	396	128	114	123	184	Diatomaceæ. Cyanophyceæ. Infusoria.
September, . . .	368	321	247	152	156	241	Diatomaceæ. Cyanophyceæ. Infusoria.
October, ...	510	320	285	120	136	171	Diatomaceæ. Cyanophyceæ. Infusoria
November, . . .	242	257	253	155	153	187	Diatomaceæ. Infusoria.
December, ...	75	89	87	145	136	215	Diatomaceæ. Infusoria.
Mean, ...	354	220	149	148	169	196	

Framingham Reservoir No. 3, 1898.

[Standard units per cubic centimeter.]

MONTH.	Organisms.			Amorphous.			Principal Organisms.
	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.	
January, ...	539	402	260	180	188	183	Diatomaceæ. Infusoria. Rotifera.
February, ...	111	50	81	153	156	187	Diatomaceæ.
March, ...	95	117	84	227	226	211	– –
April, ...	375	414	336	189	201	197	Diatomaceæ. Infusoria. Rotifera.
May, ...	482	327	389	175	186	187	Diatomaceæ. Infusoria. Rotifera.
June, ...	716	512	533	134	184	211	Diatomaceæ. Cyanophyceæ. Infusoria. Rotifera.
July, ...	461	303	326	145	179	182	Diatomaceæ. Cyanophyceæ. Infusoria.
August, ...	335	340	262	94	119	156	Diatomaceæ. Chlorophyceæ. Cyanophyceæ.
September, . . .	327	389	248	191	198	133	Diatomaceæ. Cyanophyceæ. Infusoria.
October, ...	539	400	471	156	183	207	Diatomaceæ. Cyanophyceæ.
November, ...	404	381	344	150	153	157	Diatomaceæ Cyanophyceæ. Infusoria. Rotifera.
December, ...	96	147	111	147	185	165	Diatomaceæ.
Mean, ...	390	315	287	162	180	181	

TABLE No. 30 — *Continued.*

Whitehall Reservoir, 1898.

[Standard units per cubic centimeter.]

MONTH.	ORGANISMS.	AMORPHOUS.	Principal Organisms.
	Surface.	Surface.	
January,	29	106	- -
February,	80	97	- -
March,	350	190	Infusoria. Rotifera.
April,	1,686	209	Diatomaceæ. Chlorophyceæ. Infusoria. Rotifera.
May,	971	348	Diatomaceæ. Chlorophyceæ. Infusoria. Rotifera.
June,	699	210	Diatomaceæ. Chlorophyceæ. Infusoria. Rotifera.
July,	882	222	Cyanophyceæ. Chlorophyceæ.
August,	671	201	Chlorophyceæ. Cyanophyceæ. Infusoria.
September,	330	143	Diatomaceæ. Cyanophyceæ. Infusoria.
October,	1,239	220	Diatomaceæ. Cyanophyceæ. Infusoria. Rotifera.
November,	1,243	305	Diatomaceæ. Infusoria.
December,	108	173	Diatomaceæ. Infusoria.
Mean,	690	202	

Hopkinton Reservoir, 1898.

[Standard units per cubic centimeter.]

MONTH.	ORGANISMS.				AMORPHOUS.				Principal Organisms.
	Surface.	Mid-depth.	Bottom.	Inlet.	Surface.	Mid-depth.	Bottom.	Inlet.	
January,	228	156	287	14	166	164	168	105	Diatomaceæ.
February,	611	187	156	10	128	126	141	101	Diatomaceæ. Infusoria.
March,	170	119	116	35	123	125	139	76	Diatomaceæ.
April,	550	306	405	30	150	164	176	76	Diatomaceæ. Cyanophyceæ. Infusoria.
May,	2,041	533	423	112	155	142	156	120	Diatomaceæ. Infusoria. Rotifera.
June,	2,292	632	146	72	150	149	114	124	Diatomaceæ. Cyanophyceæ. Infusoria.
July,	2,186	778	378	66	131	117	123	99	Diatomaceæ. Cyanophyceæ. Infusoria.
August,	1,539	405	48	49	94	108	112	79	Diatomaceæ. Cyanophyceæ.
September,	782	281	90	47	97	129	113	74	Diatomaceæ. Cyanophyceæ.
October,	562	335	290	97	105	89	98	94	Cyanophyceæ.
November,	154	260	206	22	120	133	122	66	Cyanophyceæ.
December,	211	228	239	25	139	130	125	76	- -
Mean,	944	352	232	48	130	131	132	91	

TABLE No. 30 — *Continued.*

Ashland Reservoir, 1898.

[Standard units per cubic centimeter.]

MONTH.	ORGANISMS.				AMORPHOUS.				Principal Organisms.
	Surface.	Mid-depth.	Bottom.	Inlet.	Surface.	Mid-depth.	Bottom.	Inlet.	
January, . .	457	124	170	25	142	160	164	166	Diatomaceæ. Rotifera.
February, . .	130	87	75	32	90	113	106	102	– –
March, . .	178	63	79	37	110	132	126	79	Infusoria. Rotifera.
April, . . .	144	143	91	30	91	99	115	81	– –
May, . . .	137	116	117	108	105	106	119	143	Diatomaceæ.
June, . . .	335	99	73	221	97	116	120	124	Diatomaceæ.
July, . . .	935	123	100	393	110	106	148	114	Diatomaceæ. Cyanophyceæ.
August, . .	189	79	60	114	73	95	130	72	Diatomaceæ.
September, . .	299	133	63	46	95	111	112	97	Chlorophyceæ. Cyanophyceæ.
October, . .	173	123	100	45	85	87	92	107	Cyanophyceæ.
November, . .	97	110	91	23	98	99	106	68	Diatomaceæ.
December, . .	82	123	108	17	101	111	97	87	Diatomaceæ.
Mean, . .	263	110	94	91	100	111	120	103	

Framingham Reservoir No. 2, 1898.

[Standard units per cubic centimeter.]

MONTH.	ORGANISMS.				AMORPHOUS.				Principal Organisms.
	Surface.	Mid-depth.	Bottom.	Inlet.	Surface.	Mid-depth.	Bottom.	Inlet.	
January, . .	29	25	28	39	124	123	131	102	– –
February, . .	40	35	26	31	96	112	119	96	– –
March, . .	64	46	30	45	119	97	93	100	– –
April, . . .	93	96	94	68	130	112	143	121	Diatomaceæ.
May, . . .	162	186	190	208	145	180	181	143	Diatomaceæ. Infusoria. Rotifera.
June, . . .	417	236	125	233	198	187	212	151	Diatomaceæ. Cyanophyceæ. Infusoria.
July, . . .	1,041	645	384	289	181	249	220	200	Chlorophyceæ. Cyanophyceæ.
August, . .	527	552	149	210	127	179	224	103	Chlorophyceæ. Cyanophyceæ. Infusoria.
September, . .	195	106	97	243	132	150	153	141	Cyanophyceæ.
October, . .	298	220	181	112	132	129	124	89	Cyanophyceæ.
November, . .	44	55	55	55	107	108	112	103	– –
December, . .	28	19	34	22	99	125	116	138	– –
Mean, . .	245	185	116	130	133	146	152	124	

TABLE No. 30 — *Continued.*

Lake Cochituate, opposite Gate-house, 1898.

[Standard units per cubic centimeter.]

MONTH.	ORGANISMS.			AMORPHOUS.			Principal Organisms.
	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.	
January,	890	845	931	159	209	312	Diatomaceæ. Cyanophyceæ. Infusoria.
February,	466	572	614	162	218	460	Diatomaceæ. Infusoria.
March,	328	278	406	154	151	222	Diatomaceæ. Infusoria. Rotifera.
April,	819	813	842	216	214	290	Diatomaceæ. Infusoria.
May,	799	779	721	124	147	283	Diatomaceæ. Infusoria. Rotifera.
June,	811	267	329	112	115	232	Diatomaceæ. Cyanophyceæ.
July,	470	355	992	121	129	580	Diatomaceæ. Cyanophyceæ. Crenothrix.
August,	820	421	453	107	120	794	Diatomaceæ. Cyanophyceæ. Crenothrix.
September,	749	525	479	111	124	526	Diatomaceæ. Cyanophyceæ.
October,	717	748	357	101	141	740	Diatomaceæ. Cyanophyceæ.
November,	1,451	1,323	1,037	174	176	256	Diatomaceæ. Cyanophyceæ. Crenothrix.
December,	1,940	1,576	1,188	162	167	358	Diatomaceæ. Cyanophyceæ.
Mean,	830	709	696	142	159	421	

Spot Pond, opposite Melrose Pumping Station, 1898.

[Standard units per cubic centimeter.]

MONTH.	ORGANISMS.			AMORPHOUS.			Principal Organisms.
	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.	
January,	-	-	-	-	-	-	- -
February,	-	-	-	-	-	-	- -
March,	226	259	318	178	208	263	Diatomaceæ. Infusoria. Rotifera.
April,	617	682	684	189	207	217	Diatomaceæ. Infusoria. Rotifera.
May,	1,067	958	723	195	194	188	Diatomaceæ. Cyanophyceæ. Infusoria. Rotifera.
June,	826	520	351	163	185	254	Diatomaceæ. Chlorophyceæ. Cyanophyceæ. Infusoria.
July,	599	373	176	251	235	360	Chlorophyceæ. Cyanophyceæ. Infusoria.
August,	541	540	130	154	188	418	Diatomaceæ. Cyanophyceæ. Infusoria. Rotifera.
September,	260	222	105	204	219	433	Diatomaceæ. Cyanophyceæ.
October,	194	313	222	227	226	259	Diatomaceæ. Cyanophyceæ.
November,	315	344	265	235	199	215	Diatomaceæ. Cyanophyceæ. Infusoria.
December,	200	108	151	174	318	290	Diatomaceæ. Infusoria.
Mean,	485	432	312	197	218	290	

TABLE No. 30 — *Concluded.*

Chestnut Hill Reservoir, 1898.

[Standard units per cubic centimeter.]

MONTH.	Organisms.				Amorphous				Principal Organisms.
	Surface.	Mid-depth.	Bottom.	Inlet (Sudbury Aqueduct.)	Surface.	Mid-depth.	Bottom.	Inlet (Sudbury Aqueduct.)	
January, . .	-	-	-	130	-	-	-	125	- -
February, . .	-	-	-	68	-	-	-	87	- -
March, . . .	237	177	145	78	136	125	149	131	Diatomaceæ. Infusoria.
April, . . .	260	223	235	235	134	145	141	173	Diatomaceæ. Infusoria.
May, . . .	345	270	215	419	140	150	139	207	Diatomaceæ. Infusoria. Rotifera.
June, . . .	512	282	77	569	94	106	122	181	Diatomaceæ. Cyanophyceæ. Infusoria.
July, . . .	1,129	508	233	472	162	154	166	221	Diatomaceæ. Chlorophyceæ. Cyanophyceæ. Infusoria.
August, . . .	607	391	156	421	111	144	140	202	Diatomaceæ. Chlorophyceæ. Cyanophyceæ. Infusoria.
September, . .	500	419	237	380	133	142	440	206	Diatomaceæ. Cyanophyceæ. Infusoria.
October, . . .	398	346	271	379	119	128	159	178	Diatomaceæ. Cyanophyceæ.
November, . .	232	232	204	366	119	132	153	183	Diatomaceæ.
December, . .	375	264	169	134	180	190	200	209	- -
Mean, . .	460	311	194	304	133	142	181	175	

Outlets from Chestnut Hill and Brookline Reservoirs and Tap in Boston, 1898.

[Standard units per cubic centimeter.]

MONTH.	Organisms.			Amorphous.		
	Effluent Gate-house, Chestnut Hill Reservoir.	Gate-house, Brookline Reservoir.	Tap in Park Square, Boston.	Effluent Gate-house, Chestnut Hill Reservoir.	Gate-house, Brookline Reservoir.	Tap in Park Square, Boston.
January, . . .	309	491	391	135	158	134
February, . .	122	289	122	103	112	99
March, . . .	158	114	100	123	112	110
April, . . .	189	200	173	146	145	122
May, . . .	238	282	213	141	150	184
June, . . .	447	245	279	98	126	199
July, . . .	598	485	302	147	148	153
August, . . .	378	248	241	126	134	130
September, . .	463	200	359	139	108	115
October, . . .	363	285	273	142	100	118
November, . .	210	305	199	124	124	118
December, . .	169	130	103	147	99	120
Mean, . .	304	273	230	131	126	131

TABLE No. 31. — *Bacterial Examinations of Water from Various Parts of the Metropolitan Water Works, 1898.*

[Number of bacteria per cubic centimeter.]

MONTH.	CHESTNUT HILL RESERVOIR.					BROOKLINE RESERVOIR.	Tap in Park Square, Boston.
	Surface.	Mid-depth.	Bottom.	Inlet (Sudbury Aqueduct).	Effluent Gate-house.	Gate-house.	
January, . .	–	–	–	375	148	134	85
February, .	–	–	–	336	181	202	120
March, . .	114	113	163	427	120	224	118
April, . .	309	376	335	319	280	384	199
May, . .	76	85	117	223	82	158	87
June, . .	90	103	174	108	95	137	119
July, . .	–	–	–	–	–	–	–
August, . .	45	34	46	114	35	58	92
September, .	48	55	96	51	50	76	115
October, . .	50	60	73	86	75	87	92
November, .	43	45	41	88	100	69	67
December, .	38	35	41	153	58	47	57
Mean, .	90	101	121	207	111	143	96

Feeders of Lake Cochituate, Means of Monthly Observations, 1898.

[Temperature in degrees Fahrenheit; organisms and amorphous matter in standard units per cubic centimeter, and bacteria in number per cubic centimeter.]

	Temperature.	Organisms.	Amorphous.	Bacteria.
Beaver Dam Brook, ...	51.1	130	162	689
Beaver Dam Brook (last culvert), .	51.4	121	147	730
Course Brook, ...	51.9	89	129	605
Dug Pond, ...	52.5	611	147	465
Circular Dam, at south end of lake, .	51.2	95	144	904
Pegan Brook, ...	53.0	136	203	3,659
Snake Brook, ...	48.5	69	487	852

TABLE No. 32. — *Colors of Water from Various Parts of the Metropolitan Water Works, 1898.*

[Platinum standard.]

MONTH.	NASHUA RIVER.	SUDBURY RESERVOIR.			FRAMINGHAM RESERVOIR No. 3.			WHITEHALL RESERVOIR.
	Surface.	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.	Surface.
January,	–	.57	.67	.74	.52	.53	.55	.68
February,	–	.64	.58	.57	.56	.56	.57	.53
March,	–	.45	.53	.55	.51	.51	.52	.68
April,	.49.	.45	.45	.45	.47	.47	.46	.73
May,	.50	.36	.36	.37	.38	.38	.38	.74
June,	.53	.33	.33	.34	.33	.33	.34	.75
July,	.45	.34	.35	.38	.31	.32	.33	.75
August,	.68	.29	.30	.36	.31	.33	.37	.71
September,	.65	.42	.44	.49	.33	.34	.34	.63
October,	.68	.44	.44	.45	.44	.44	.46	.63
November,	.59	.48	.49	.50	.46	.46	.46	.69
December,	.40	.58	.63	.68	.55	.55	.55	.75
Mean,	.55	.45	.46	.49	.43	.46	.44	.69

TABLE No. 32 — *Continued.*

[Platinum standard.]

MONTH.	HOPKINTON RESERVOIR.			ASHLAND RESERVOIR.			FRAMINGHAM RESERVOIR No. 2.		
	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.
January,	.64	.64	.66	.74	.73	.70	.68	.69	.70
February,	.65	.65	.66	.70	.69	.69	.61	.61	.61
March,	.63	.64	.65	.63	.64	.65	.56	.56	.56
April,	.64	.64	.64	.67	.66	.66	.68	.68	.67
May,	.62	.62	.63	.68	.68	.68	.74	.74	.74
June,	.62	.58	.57	.69	.67	.66	.87	.87	.86
July,	.62	.56	.55	.68	.66	.62	.82	.85	.87
August,	.60	.60	.54	.64	.64	.63	1.09	1.10	1.23
September,	.62	.56	.51	.66	.63	.61	1.64	1.64	1.64
October,	.57	.57	.54	.62	.62	.58	1.27	1.27	1.28
November,	.60	.60	.60	.65	.65	.65	.91	.91	.91
December,	.64	.61	.64	.67	.67	.66	.63	.63	.63
Mean,	.62	.61	.60	.67	.66	.65	.88	.88	.89

TABLE NO. 32 — *Continued.*

[Platinum standard.]

MONTH.	FRAMINGHAM RESERVOIR No. 1.	LAKE COCHITUATE.				SPOT POND.		
	Surface.	Surface.	Mid-depth.	Bottom.	Influent Streams.*	Surface.	Mid-depth.	Bottom.
January,	0.70	0.35	0.37	0.40	0.57	-	-	-
February,	0.58	0.40	0.36	0.48	0.65	-	-	-
March,	0.54	0.40	0.36	0.40	0.74	0.47	0.49	0.60
April,	0.56	0.41	0.41	0.44	0.75	0.46	0.46	0.47
May,	0.67	0.37	0.37	0.49	1.08	0.44	0.44	0.44
June,	0.77	0.32	0.32	1.01	1.21	0.44	0.43	0.44
July,	0.73	0.28	0.33	1.44	0.84	0.49	0.49	0.59
August,	0.84	0.26	0.34	1.97	1.01	0.44	0.47	0.81
September,	1.29	0.23	0.32	1.60	0.57	0.46	0.46	1.25
October,	1.16	0.23	0.32	1.95	0.92	0.43	0.46	0.48
November,	0.89	0.32	0.34	0.78	0.64	0.45	0.45	0.46
December,	0.64	0.34	0.33	0.40	0.55	0.45	0.64	0.96
Mean,	0.78	0.33	0.35	0.95	0.79	0.46	0.48	0.65

* The colors given in this column represent the combined colors of the waters of the four principal feeders. The color of each is determined monthly, and due weight is given, in combining the results, to the sizes of the streams.

TABLE NO. 32 — *Concluded.*

[Platinum standard.]

MONTH.	CHESTNUT HILL RESERVOIR.					BROOKLINE RESERVOIR.	Tap in Park Square, Boston.
	Surface.	Mid-depth.	Bottom.	Inlet (Sudbury Aqueduct).	Effluent Gate-house.	Gate-house.	
January,	-	-	-	.66	.61	.48	.61
February,	-	-	-	.60	.59	.54	.57
March,	.48	.49	.50	.53	.50	.50	.49
April,	.51	.51	.51	.54	.52	.51	.52
May,	.37	.37	.38	.38	.38	.37	.37
June,	.30	.31	.31	.34	.31	.32	.31
July,	.28	.28	.30	.32	.28	.28	.28
August,	.26	.27	.33	.36	.26	.28	.27
September,	.26	.26	.73	.33	.25	.25	.25
October,	.32	.32	.33	.42	.32	.28	.30
November,	.38	.38	.38	.44	.37	.34	.37
December,	.41	.41	.41	.54	.45	.44	.45
Mean,	.36	.36	.42	.46	.40	.38	.40

TABLE No. 33. — *Alkalinity of Water from Various Parts of the Metropolitan Water Works, 1898.*

[In parts per 100,000 of calcium carbonate.]

MONTH.	NASHUA RIVER.	SUDBURY RESERVOIR.			FRAMINGHAM RESERVOIR No. 3.			WHITEHALL RESERVOIR.	HOPKINTON RESERVOIR.			
	Surface.	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.	Surface.	Surface.	Mid-depth.	Bottom.	Inlet.
January, . .	–	1.13	1.12	1.15	1.15	1.14	1.15	0.33	0.72	0.75	0.75	0.67
February, . .	–	1.07	1.14	1.13	1.11	1.12	1.13	0.39	0.80	0.81	0.83	0.71
March, . .	–	0.78	0.94	1.02	0.96	0.98	0.97	0.36	0.82	0.82	0.82	0.66
April, . .	0.73	0.84	0.83	0.83	0.87	0.87	0.88	0.35	0.78	0.77	0.77	0.90
May, . .	0.83	0.84	0.84	0.84	0.85	0.84	0.86	0.38	0.80	0.80	0.80	0.93
June, . .	1.02	0.99	1.00	0.99	0.97	0.98	0.98	0.38	0.79	0.79	0.79	1.01
July, . .	1.04	1.00	1.02	1.00	1.01	1.01	1.00	0.40	0.88	0.88	0.86	–
August, .	1.12	1.29	1.31	1.38	1.30	1.25	1.28	0.47	1.00	0.97	0.93	1.11
September, .	1.10	1.24	1.30	1.30	1.25	1.24	1.20	0.44	0.86	0.86	0.88	1.50
October, .	0.95	1.26	1.27	1.28	1.29	1.29	1.29	0.46	0.97	0.99	1.00	1.20
November, .	0.80	1.18	1.17	1.19	1.22	1.22	1.22	0.33	0.86	0.86	0.86	0.85
December, .	0.79	1.15	1.21	1.18	1.20	1.19	1.19	0.40	0.83	0.85	0.91	0.82
Mean, .	0.93	1.06	1.10	1.11	1.06	1.09	1.10	0.40	0.84	0.85	0.85	0.93

TABLE No. 33 — *Continued.*

[In parts per 100,000 of calcium carbonate.]

MONTH.	ASHLAND RESERVOIR.				FRAMINGHAM RESERVOIR No. 2.				FRAMINGHAM RESERVOIR No. 1.	LAKE COCHITUATE.		
	Surface.	Mid-depth.	Bottom.	Inlet.	Surface.	Mid-depth.	Bottom.	Inlet.	Surface.	Surface.	Mid-depth.	Bottom.
January, . .	0.75	0.75	0.76	0.63	0.66	0.67	0.67	0.62	0.77	1.67	1.69	1.80
February, . .	0.79	0.79	0.79	0.68	0.75	0.75	0.75	0.67	0.99	1.65	1.81	2.01
March, . .	0.75	0.77	0.73	0.63	0.61	0.62	0.62	0.61	0.78	1.62	1.64	1.70
April, . .	0.75	0.74	0.74	0.73	0.76	0.76	0.76	0.74	0.81	1.55	1.57	1.77
May, . .	0.77	0.77	0.77	0.84	0.85	0.86	0.86	0.89	0.88	1.59	1.59	1.64
June, . .	0.76	0.76	0.78	0.88	0.98	0.98	0.98	1.05	1.00	1.59	1.61	1.97
July, . .	0.90	0.90	0.90	0.96	1.00	1.00	1.00	1.00	1.00	1.64	1.68	2.20
August, . .	0.88	0.89	0.88	1.13	1.14	1.08	1.11	1.34	1.21	1.70	1.70	2.30
September, .	0.84	0.84	0.84	1.16	1.20	1.18	1.26	1.40	1.40	1.70	1.70	2.50
October, . .	0.93	0.95	0.95	1.05	1.19	1.22	1.23	1.11	1.28	1.79	1.79	2.87
November, .	0.88	0.90	0.90	0.89	0.87	0.84	0.84	0.83	0.92	1.68	1.68	1.98
December, .	0.81	0.81	0.81	0.79	0.81	0.81	0.81	0.79	0.82	1.67	1.69	1.73
Mean, .	0.82	0.82	0.82	0.86	0.90	0.90	0.91	0.92	0.99	1.65	1.68	2.04

TABLE NO. 33 — *Concluded.*

[In parts per 100,000 of calcium carbonate.]

MONTH.	SPOT POND.				CHESTNUT HILL RESERVOIR.					BROOKLINE RESERVOIR.	Tap in Park Square, Boston.
	Surface.	Mid-depth.	Bottom.	Inlet.	Surface.	Mid-depth.	Bottom.	Inlet (Sudbury Aqueduct).	Effluent Gate-house.	Gate-house.	
January,	–	–	–	–	–	–	–	0.78	0.94	1.13	0.97
February,	–	–	–	–	–	–	–	0.86	1.06	1.06	1.00
March,	0.81	0.81	0.81	0.78	0.92	0.93	0.93	0.71	0.84	0.81	0·84
April,	0.81	0.82	0.82	0.82	0.83	0.83	0.83	0.81	0.82	0.82	0.80
May,	0.91	0.92	0.94	0.93	0.98	0.98	0.98	0.94	0.94	1.02	0.96
June,	0.99	1.00	1.01	1.01	0.98	0.99	1.01	1.04	1.00	1.04	1.04
July,	1.06	1.04	1.04	1.06	1.04	1.04	1.00	1.08	1.00	1.08	1.08
August,	1.21	1.21	1.70	1.26	1.20	1.22	1.25	1.21	1.23	1.20	1.21
September,	1.20	1.20	2.50	1.20	1.50	1.50	1.90	1.50	1.50	–	1.20
October,	1.36	1.36	1.38	1.37	1.40	1.39	1.41	1.31	1.37	1.54	1.39
November,	1.16	1.17	1.17	1.16	1.20	1.22	1.22	1.22	1.22	1.29	1.22
December,	1.13	–	–	1.11	1.16	1.14	1.16	1.27	1.19	1.29	1.19
Mean,	1.06	1.06	1.26	1.07	1.12	1.12	1.17	1.06	1.09	1.11	1.08

TABLE NO. 34. — *Temperatures of Water from Various Parts of the Metropolitan Water Works, 1898.*

[The temperatures are taken at the same places and times as the samples for microscopical examination; the depth given for each reservoir is the depth when water is at high-water mark where the temperatures are taken.]

[Degrees Fahrenheit.]

MONTH.	SUDBURY RESERVOIR (DEPTH AT PLACE OF OBSERVATION 54.5 FEET).			FRAMINGHAM RESERVOIR NO. 3 (DEPTH AT PLACE OF OBSERVATION 20.5 FEET).			HOPKINTON RESERVOIR (DEPTH AT PLACE OF OBSERVATION 54.3 FEET).		
	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.
January,	34.3	35.9	37.8	32.9	34.0	36.0	33.7	34.8	37.7
February,	33.2	35.6	37.7	34.1	35.8	36.4	34.9	36.8	38.7
March,	36.8	37.3	38.9	38.4	38.8	39.3	39.1	39.1	39.6
April,	45.7	45.6	45.4	45.1	45.0	44.8	44.9	44.9	43.9
May,	56.2	52.9	50.2	56.4	55.8	55.0	56.7	49.2	46.9
June,	70.9	60.9	54.6	70.9	69.9	68.7	69.3	51.9	47.9
July,	76.0	69.8	66.4	75.3	73.8	71.1	75.5	52.7	48.4
August,	76.4	72.8	70.3	77.4	75.7	73.4	76.3	54.3	49.1
September,	71.0	68.9	68.2	71.9	70.8	69.8	71.9	61.4	51.9
October,	59.1	58.2	57.8	60.5	60.2	60.0	61.1	59.0	51.7
November,	44.8	44.7	44.7	44.3	44.7	45.4	46.0	45.8	45.8
December,	33.3	33.6	34.6	33.8	35.9	37.7	37.0	37.0	37.0
Mean,	53.1	51.4	50.6	53.4	50.9	53.1	53.9	47.2	47.4

TABLE No. 34 — *Continued.*

[Degrees Fahrenheit.]

MONTH.	ASHLAND RESERVOIR (DEPTH AT PLACE OF OBSERVATION 40.7 FEET).			FRAMINGHAM RESERVOIR NO. 2 (DEPTH AT PLACE OF OBSERVATION 20.5 FEET).			LAKE COCHITUATE (DEPTH AT PLACE OF OBSERVATION 62.0 FEET).		
	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.
January, . .	34.2	35.3	36.5	32.9	34.0	34.9	35.9	36.4	37.7
February, . .	35.0	36.3	38.1	33.8	34.8	36.1	34.7	36.6	37.8
March, . .	39.3	39.7	39.8	38.9	39.1	39.7	37.8	37.9	38.3
April, . .	44.8	44.6	44.3	45.9	45.7	45.4	41.6	41.3	40.6
May, . . .	55.1	51.9	48.9	57.0	56.3	55.6	54.8	47.7	44.4
June, . . .	70.8	59.0	53.6	71.7	70.8	69.2	65.1	47.2	44.6
July, . . .	75.8	60.4	54.4	76.4	74.6	71.9	–	–	–
August, . .	76.6	62.3	55.5	78.1	76.0	73.8	76.9	50.5	45.7
September, .	70.7	64.3	52.3	72.5	72.1	70.1	71.5	50.4	44.9
October, . .	60.0	58.8	51.7	60.7	60.3	59.9	59.3	52.3	44.6
November, .	47.1	47.1	47.1	44.4	44.8	45.5	45.3	45.3	42.8
December, . .	36.5	36.8	37.5	33.8	36.0	38.0	36.3	36.4	36.6
Mean, . .	53.8	49.7	46.6	53.8	53.7	53.3	–	–	–

TABLE No. 34 — *Concluded.*

[Degrees Fahrenheit.]

MONTH.	SPOT POND (DEPTH AT PLACE OF OBSERVATION 28.0 FEET).			CHESTNUT HILL RESERVOIR (DEPTH AT PLACE OF OBSERVATION 26.0 FEET).					BROOKLINE RESERVOIR.	Tap in Park Square, Boston.
	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.	Inlet (Sudbury Aqueduct).	Effluent Gate-house.	Gate-house.	
January, . .	–	–	–	–	–	–	35.2	35.8	36.4	36.9
February, . .	–	–	–	–	–	–	34.9	35.1	35.9	36.0
March, . .	40.7	40.8	41.3	42.8	42.5	41.6	40.2	39.1	40.7	40.5
April, . .	47.0	47.0	47.3	46.4	45.5	45.1	46.2	46.1	46.3	45.9
May, . .	57.8	55.4	52.8	56.8	54.6	50.2	55.0	55.1	55.5	54.3
June, . .	68.0	64.3	59.8	69.4	65.2	51.9	64.0	65.0	65.6	64.1
July, . .	75.3	71.3	64.1	77.0	72.3	53.3	69.6	71.8	72.0	70.5
August, . .	74.6	72.7	62.1	76.5	74.4	54.6	73.8	74.5	74.9	72.9
September, .	69.3	68.6	62.8	71.7	70.2	56.0	69.9	70.5	71.5	70.4
October, . .	58.8	57.9	58.6	60.5	60.0	58.8	59.9	60.3	60.9	60.4
November, .	45.2	47.5	48.1	45.3	45.4	45.6	45.8	46.2	46.8	48.7
December, .	35.9	37.0	38.0	36.3	36.0	36.0	35.6	35.1	35.9	36.6
Mean, .	–	–	–	–	–	–	52.5	52.9	53.5	53.1

Table No. 35. — *Temperatures of the Air at Three Stations on the Metropolitan Water Works.*

[Degrees Fahrenheit.]

MONTHS, 1898.	CHESTNUT HILL RESERVOIR.			FRAMINGHAM.			CLINTON.		
	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.
January, . .	53.0	—9.0	26.6	53.0	—14.0	25.9	52.0	—11.0	25.1
February, . .	55.5	—8.0	30.2	53.0	—14.0	29.3	55.0	—9.0	27.9
March, . .	66.0	19.0	40.3	65.0	19.0	42.3	63.0	14.0	40.6
April, . .	72.0	19.0	43.5	71.0	20.0	44.2	71.0	15.0	40.7
May, . . .	82.0	31.5	56.4	83.0	30.0	57.3	85.0	30.0	55.5
June, . . .	91.0	42.0	67.0	92.0	41.0	67.7	95.0	38.0	66.6
July, . . .	98.0	51.0	72.2	100.0	48.0	72.8	98.0	45.0	73.2
August, . .	93.5	48.0	72.6	92.0	45.0	72.4	93.0	43.0	72.3
September, .	91.5	39.5	66.2	92.0	39.0	65.7	93.0	30.0	64.7
October, . .	86.0	33.0	53.5	85.0	30.0	52.9	85.0	25.0	51.6
November, .	62.5	17.0	40.4	61.0	17.0	40.0	60.0	17.0	39.0
December, . .	55.0	—7.5	29.4	54.0	—7.0	29.0	53.0	—5.0	27.6
Average, .	-	-	49.9	-	-	50.0	-	-	48.7

APPENDIX No. 4.

Length of Water Pipes, Four Inches in Diameter and Larger, in the Several Cities and Towns supplied by the Metropolitan Water Works.

BY WHOM OWNED.	INCHES.																		TOTAL.	
	48.	42.	40.	36.	30.	28.	24.	20.	18.	16.	14.	12.	10.	8.	7.	6.	5.	4.	Feet	Miles.
Metropolitan Water Board.	121,537	8,075	-	44,533	27,050	-	31,202	38,049	-	51,941	26	12,721	353	745	-	758	-	-	336,990	63.83
Boston, . . .	33,671	16,813	23,104	39,984	81,621	244	81,610	88,034	-	141,057	-	1,011,706	76,833	477,120	-	1,433,012	-	123,178	3,627,987	687.12
Somerville, . .	-	-	-	-	-	-	-	2,852	387	1,050	8,037	54,485	32,492	73,070	-	180,254	-	34,400	387,027	73.30
Malden, . . .	-	-	-	-	-	-	-	-	707	-	13,023	53,929	18,944	57,322	-	177,400	-	122,394	443,729	84.04
Chelsea, . . .	-	-	-	-	-	-	-	-	-	2,348	-	-	37,833	25,140	-	117,618	-	12,381	195,370	37.00
Quincy, . . .	-	-	-	-	-	-	-	2,679	-	17,513	-	19,764	17,713	73,497	994	158,738	948	85,261	377,107	71.42
Everett, . . .	-	-	-	-	-	-	2,484	2,900	-	2,233	200	5,574	20,465	14,076	-	100,362	-	52,415	200,709	38.01
Medford, . . .	-	-	-	-	-	-	-	1,972	-	6,775	9,585	22,809	26,058	60,116	-	71,243	-	71,288	269,846	51.11
Melrose, . . .	-	-	-	-	-	-	-	-	-	7,206	3,096	13,214	-	10,911	-	90,965	-	103,124	228,516	43.28
Revere,* . . .	-	-	-	-	-	-	-	-	-	24,000	4,450	3,300	7,950	14,959	-	56,506	-	60,945	172,110	32.60
Watertown, . .	-	-	-	-	-	-	-	-	-	400	12,127	5,959	4,169	17,194	-	94,530	-	12,924	147,303	27.90
Winthrop,* . .	-	-	-	-	-	-	-	-	-	-	-	-	5,000	19,176	-	15,483	-	67,849	107,508	20.36
Belmont, . . .	-	-	-	-	-	-	-	-	-	-	-	2,161	11,102	12,896	-	50,669	-	283	77,111	14.60
Total, feet, .	155,208	24,888	23,104	84,517	108,671	244	115,296	136,486	1,094	254,523	50,544	1,205,622	258,962	856,232	994	2,547,538	948	746,442	6,571,313	-
Total, miles, .	29.39	4.71	4.38	16.01	20.58	.05	21.84	25.85	.21	48.20	9.57	228.34	49.05	162.17	.19	482.49	.18	141.36	-	1,244.57

Pipes in Newton, Hyde Park and Nahant not included in table.

*** Pipes owned by Revere Water Company.**

Number of Service Pipes, Meters and Fire Hydrants in the Several Cities and Towns supplied by the Metropolitan Water Works.

CITY OR TOWN.	Services.	Meters.	Fire Hydrants.
Boston,	84,114	4,752	7,368
Somerville,	9,806	143	831
Malden,	6,296	2,673	384
Chelsea,	5,980	97	240
Quincy,	3,469	128	471
Everett,	3,986	25	319
Medford,	3,500	80	432
Melrose,	3,374	71	248
Revere,	1,800	12	101
Watertown,	1,438	1,121	253
Winthrop,	1,322	3	87
Belmont,	493	380	120
Total,	125,578	9,485	10,854

APPENDIX NO. 5.

SUMMARY OF STATISTICS.

REPORT FOR 1898.

The Metropolitan Water Works supply the Metropolitan Water District, which includes the following cities and towns: —

CITIES AND TOWNS.	Population, Census of 1895.	Estimated Population May 1, 1898.
Boston,	496,920	533,600
Somerville,	52,200	59,400
Chelsea,	31,264	33,100
Malden,*	29,708	34,400
Newton,†	27,590	31,200
Quincy,*	20,712	23,700
Everett,	18,573	22,800
Medford,*	14,474	17,200
Melrose,	11,965	14,100
Hyde Park,†	11,826	13,200
Watertown,*	7,788	8,700
Revere,*	7,423	9,000
Winthrop,*	4,192	5,200
Belmont,*	2,843	3,500
Nahant,†	865	900
Total population of Metropolitan Water District,	738,343	810,000
Swampscott,†‡	3,259	3,500

* Partially supplied from Metropolitan Water Works. For details, see tables Nos. 13, 18-21.

† No water supplied to these places during the year from Metropolitan Water Works.

‡ Swampscott is not in the Metropolitan Water District, but it is to be supplied with water from the Metropolitan Water Works.

Sources of Supply.

SOURCE.	Area of Watershed (Square Miles).	Remarks.
Lake Cochituate,	18.87	Works built by city of Boston in 1848.
Sudbury River,	75.20	Works built by city of Boston in 1872-78.
Nashua River,	118.23	Works begun in 1895 — not finished.
Spot Pond,	2.06	To be used as a distributing reservoir.

Mode of Supply.

47.5 per cent. from gravity works.
52.5 per cent. from pumping works.

Pumping.

Chestnut Hill High-service Station: —

Builders of pumping machinery, Holly Manufacturing Company, Quintard Iron Works and E. P. Allis Company.

Description of coal used: Bituminous; George's Creek Cumberland and New River. Price per gross ton in bins, $3.80, $3.69, $3.33, $3.53. Per cent. ash, 7.4.

Melrose Station: —

Builders of pumping machinery, Knowles Pump Works.

Description of coal used: Bituminous; Loyal Hanna, George's Creek Cumberland. Price per gross ton in bins, $4.41. Per cent. ash, 10.8.

	Chestnut Hill Station.		Melrose Station.
	Engines Nos. 1 and 2.	Engines Nos. 3 and 4.	
Coal consumed for year, in pounds,	3,977,254	5,941,002	769,690
Cost of pumping figured on pumping-station expenses,	$21,224 94	$21,282 54	$3,769 32
Total pumpage for year, million gallons,	6,796.89	6,441.58	368.06
Gallons pumped per pound of coal,	1,709	1,085	478
Duty, on basis of plunger displacement,	62,900,000	118,370,000	50,400,000
Cost per million gallons raised to reservoir,	$3.123	$3.304	$10.241
Cost per million gallons raised one foot,	$0.075	$0.026	$0.084

Consumption.

Estimated total population of the twelve cities and towns supplied wholly or partially during the year 1898,	779,980
Total consumption, gallons,	28,935,140,000
Furnished from Metropolitan Water Works sources, gallons,	27,769,070,000
Furnished from local sources, gallons,	1,166,070,000
Average daily consumption, gallons,	79,274,000
Gallons per day each inhabitant,	103

Distribution. — Metropolitan Water Works Mains.

Kind of pipe used,	Cast-iron and cement.
Sizes,	48-inch to 6-inch.
Extended,	76,211 feet = 14.43 miles.
Taken from Boston Water Works,	35,263 feet = 6.68 miles.
Total now in use,	336,990 feet = 63.83 miles.
Stop gates added,	59
Stop gates in lines taken,	41
Stop gates now in use (mains and connections),	198
Number of blow-off gates,	124
Length of pipes in the cities and towns supplied by Metropolitan Water Works,	1,244.57 miles.
Service pipes,	125,578
Meters,	9,485
Fire hydrants,	10,854

APPENDIX No. 6.

LEGISLATION OF THE YEAR 1898 AFFECTING THE METROPOLITAN WATER BOARD.

[Chapter 166 of the Acts of the Year 1898.]

AN ACT RELATIVE TO THE METROPOLITAN WATER BOARD.

Be it enacted, etc., as follows:

Metropolitan water board may make agreements for care of certain lands, etc.

SECTION 1. The metropolitan water board may make agreements with the metropolitan park commission, or with any park commission or any officer or board of any city or town in which any lands, rights, easements, or interest in lands in the control of said metropolitan water board are situated, for the care and control, with or without police protection, of such lands, rights, easements, or interest in lands, for such period and upon such terms and conditions as may be mutually agreed.

SECTION 2. This act shall take effect upon its passage. [*Approved March 12, 1898.*

[Chapter 293 of the Acts of the Year 1898.]

AN ACT RELATIVE TO THE PURCHASE AND SALE OF THE PROPERTY OF THE MARBLEHEAD WATER COMPANY.

Be it enacted, etc., as follows:

Marblehead Water Company may sell its water rights, etc.

Town of Swampscott may purchase upon certain terms, etc.

SECTION 1. The Marblehead Water Company, a corporation established by chapter one hundred and sixty-three of the acts of the year eighteen hundred and eighty-three, may sell all its water rights, estates, franchises and privileges, or any part thereof, to any person, or municipal or other corporation, notwithstanding the provisions of section nine of said act; and the town of Swampscott is hereby authorized to purchase the same or any part thereof upon terms agreed or to be agreed upon by the parties, and upon such purchase said town shall become entitled to all the rights and privileges of said corporation, except as otherwise provided by agreement of the parties. Any vote heretofore passed by a majority of the legal voters of the town of Swampscott present and voting thereon at a legal town meeting to purchase said property, rights, privileges and franchises of the Marblehead Water Company as herein provided, or authorizing the selectmen to purchase the same, is hereby ratified as a vote of purchase thereof, and shall have the same effect as a vote of purchase thereof as though the authority hereby given had been granted prior to such vote.

May supply itself with water, etc.

SECTION 2. Said town of Swampscott upon acquiring the property of said Marblehead Water Company, as herein provided, may supply itself and its inhabitants with water for the extinguishment of fires and for domestic and other purposes, obtaining the same from any or all of the sources specified, and in the manner specified in said chapter one hundred and sixty-three of the acts of the year eighteen hundred and eighty-three; or from the city of Lynn, or from the metropolitan water board, as now authorized by law.

May establish hydrants, etc., take lands, etc.

SECTION 3. Said town may establish fountains and hydrants and relocate or discontinue the same; may regulate the use of water and fix and collect rates to be paid for the use of the same; and for the purposes aforesaid may hold and convey such water through said town; and may also take and hold by purchase or otherwise all lands, rights of way and easements necessary to enable said town to supply itself and its inhabitants with water, for holding, storing, purifying and preserving such water, and for conveying the same to any part of said town of Swampscott; and may erect on lands thus taken or held proper dams, reservoirs, buildings, fixtures or other structures; and may make excavations, procure and operate machinery, and provide such other means and appliances as may be necessary for the establishment and maintenance of complete and effective water works, and may construct and lay down conduits, pipes and other works, under and over any lands, water courses, railroads, or public or private ways, and along any such ways, in such manner as not unnecessarily to obstruct the same; and for the purpose of constructing, maintaining and repairing such conduits, pipes or other works, and for all proper purposes of this act said town may dig up any such lands, and may enter upon and dig up any such ways in such manner as to cause the least hindrance to public travel thereon.

May erect structures, lay pipes, etc.

Title of lands to vest in town, etc.

SECTION 4. The title to all lands taken or purchased under the provisions of this act shall vest in said town, and the lands so taken may be managed, improved and controlled by the board of water commissioners hereinafter provided for, in such manner as they shall deem for the best interests of said town.

Damages.

SECTION 5. Said town shall pay all damages sustained by any person or corporation in property by the taking of any lands, rights of way or easements, or by any other thing done by said town under the authority of this act. Any person or corporation sustaining damages as aforesaid under this act, who fails to agree with said town as to the amount of damages sustained, may have the damages assessed and determined in the manner provided by law when land is taken for the laying out of highways, on making application at any time within the period of one year from the taking of such land or other property or the doing of other injury under the authority of this act; but no such application shall be made after the expiration of one year.

Town of Swampscott Water Loan.

SECTION 6. Said town may for the purpose of paying for the property, franchises, rights and privileges acquired under and by virtue of this act, and for any other purposes thereof, issue from time to time bonds or notes to an amount not exceeding one hundred and fifty thousand dollars. Such bonds or notes shall bear on their face the words, Town of Swampscott Water Loan, shall be payable at the expiration of periods not exceeding thirty years from the date of issue, shall bear interest, payable semi-annually, at a rate not exceeding four per cent. per annum, and shall be signed by the treasurer of the town and countersigned by the water commissioners hereinafter provided for. Said town may sell such securities at public or private sale, or pledge the same for money borrowed for the purposes of this act, and upon such terms and conditions as it may deem proper: *provided*, that such securities shall not be sold for less than the par value thereof. Said town shall provide at the time of contracting said loan for the establishment of a sinking fund and shall annually contribute to such fund a sum sufficient with the accumulations thereof to pay the principal of said loan at maturity. Said sinking fund shall remain inviolate and pledged to the payment of said loan and shall be used for no other purpose.

Proviso.

Sinking fund.

May provide for annual payments on loan.

SECTION 7. Said town instead of establishing a sinking fund may at the time of authorizing said loan provide for the payment thereof in such annual proportionate payments as will extinguish the same within the time prescribed in this act; and when such vote has been passed the amount required thereby shall without further vote be assessed by the assessors of said town in each year thereafter until the debt incurred by said loan shall be extinguished, in the same manner as other taxes are assessed under the provisions of section thirty-four of chapter eleven of the Public Statutes.

Payment of expenses, etc.

SECTION 8. Said town shall raise annually by taxation a sum which with the income derived from water rates will be sufficient to pay the current annual expenses of operating its water works, including therein any annual payment to said metropolitan water board or to the city of Lynn, and the interest as it accrues on the notes and bonds issued as aforesaid by said town, and such contributions to the sinking fund and payments on the principal as may be required under the provisions of this act.

Penalty for corruption of water, etc.

SECTION 9. Whoever uses any water taken under this act without the consent of said town, or wilfully or wantonly corrupts, pollutes or diverts any of the waters taken or held by said town pursuant to the provisions of this act, or destroys or injures any structure, work or other property owned, held or used by said town under the authority and for the purposes of this act, shall forfeit and pay to said town three times the amount of damages assessed therefor, to be recovered in an action of tort; and upon conviction of either of the above wilful or wanton acts shall be punished by a fine not exceeding three hundred dollars or by imprisonment not exceeding one year.

Liability for payment of rent for use of water, etc.

SECTION 10. The occupant of any tenement shall be liable for the payment of the rent for the use of water in such tenement, and the owner shall also be liable in case of non-payment by the occupant for all sums due for the use of water under this act, to be collected in an action of contract in the name of the town of Swampscott.

Water commissioners, election, terms, etc.

SECTION 11. Said town shall at a legal meeting called for the purpose elect by ballot three persons to hold office, one until the expiration of three years, one until the expiration of two years and one until the expiration of one year from the next succeeding annual town meeting, to constitute a board of water commissioners; and at each annual town meeting thereafter one such commissioner shall be elected by ballot for the term of three years. No person shall be a water commissioner who holds any other town office by popular election. All the authority granted to the town by this act and not otherwise

To be trustees of sinking fund, etc.

Vacancy.

specially provided for shall be vested in said board of water commissioners, who shall be subject however to such instructions, rules and regulations as said town may impose by its vote. The said commissioners shall be trustees of the sinking fund herein provided for and a majority of said commissioners shall constitute a quorum for the transaction of business relative both to the water works and to the sinking fund. Any vacancy occurring in said board from any cause may be filled for the unexpired term by said town at any legal meeting held for the purpose.

To fix prices for use of water, etc.

To render an account of their doings, etc.

SECTION 12. Said commissioners shall fix such prices or rents for the use of water as shall produce annually as near as may be a net surplus over operating expenses, including therein any annual payment to said metropolitan water board or to the city of Lynn, and interest charges equal to two per cent. of the total amount of the bonds or notes issued under this act, after paying all current expenses of operating the water works and interest upon loans. The net surplus aforesaid shall be paid into the sinking fund, if any is established hereunder, and if said surplus does not equal two per cent. of the total amount of the bonds and notes issued under this act the town shall raise by general taxation a sum which with the surplus will equal said two per cent., and shall contribute said sum to the sinking fund. Said commissioners shall annually, and as often as the town may require, render an account of all their doings in relation to the sinking fund, and shall be governed by the provisions of section eleven of chapter twenty-nine of the Public Statutes, except as herein otherwise provided.

SECTION 13. This act shall take effect upon its passage. [*Approved April 6, 1898.*

[Chapter 295 of the Acts of the Year 1898.]

AN ACT TO PROVIDE FOR A WATER SUPPLY FOR THE TOWN OF WINTHROP.

Be it enacted, etc., as follows:

Town of Winthrop may supply itself with water, etc.

SECTION 1. The town of Winthrop may supply itself and its inhabitants with water for the extinguishment of fires and for domestic and other purposes, obtaining the same from the metropolitan water board, as provided in chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five, may establish fountains and hydrants and relocate or discontinue the same, and may regulate the use of such water and fix and collect rates to be paid for the use of the same.

May hold and convey certain water, take certain lands, etc.

SECTION 2. Said town for the purposes aforesaid may hold and convey through said town the water to be furnished by said metropolitan water board as hereinbefore provided, and may also take and hold, by purchase or otherwise, all lands, rights of way and easements necessary for holding, storing, purifying and preserving such water and for conveying the same to any part of said town of Winthrop; may erect on the lands thus taken or held proper dams, reservoirs, buildings, fixtures or other structures; may make excavations, procure and operate machinery, and provide such other means and appliances as may be necessary for the establishment and maintenance of complete and effective water works; may construct and lay down conduits, pipes and other works, under and over any lands, water courses, railroads or public or private ways, and along any such ways in such manner as not unnecessarily to obstruct the same; and for the purpose of constructing, maintaining and repairing such conduits, pipes or other works, and for all proper purposes of this act, said town may dig up any such lands, and may enter upon and dig up any such ways in such manner as to cause the least hindrance to public travel thereon. The title to all lands taken or purchased under the provisions of this act shall vest in said town, and the land so taken may be managed, improved and controlled by the board of water commissioners hereinafter provided for, in such manner as they shall deem for the best interests of said town.

May erect structures, lay pipes, etc.

Title to lands to vest in town, etc.

Description of lands, etc., to be recorded.

SECTION 3. Said town shall, within ninety days after the taking of any lands, rights of way or easements as aforesaid, otherwise than by purchase, file and cause to be recorded in the registry of deeds for the county of Suffolk a description thereof sufficiently accurate for identification, with a statement of the purpose for which the same were taken, signed by the water commissioners hereinafter provided for.

Damages.

SECTION 4. Said town shall pay all damages sustained by any person or corporation in property by the taking of any lands, rights of way or easement, or by any other thing done by said town under the authority of this act. Any person or corporation sustaining damages as aforesaid under this act, who fails to agree with said town as to the amount of damages sustained, may have the damages assessed and determined in the manner provided by law when land is taken for the laying out of highways, on making application at any time within the period of one year from the taking of such land or other property or the doing of other injury under the authority of this act; but no such application shall be made after the expiration of said one year.

Town may tender a sum as damages, etc.

SECTION 5. In every case of a petition to the superior court for an assessment of damages the town may tender to the complainant or his attorney any sum, or may bring the same into court to be paid to the complainant, for the damages by him sustained or claimed in his petition, or may in writing offer to be defaulted and that damages may be awarded against it for the sum therein expressed; and if the complainant does not accept such sum, with his costs up to that time, but proceeds in his suit, and does not recover greater damages than were so offered or tendered, not including interest on the sum recovered in damages from the date of such offer or tender, the town shall have judgment for its costs after said date, for which execution shall issue; and the complainant if he recovers damages shall be allowed his costs only to the date of such offer or tender.

Town of Winthrop Water Loan.

SECTION 6. Said town may, for the purpose of paying the necessary expenses and liabilities incurred under the provisions of this act, issue from time to time bonds, notes or scrip to an amount sufficient for such purpose, to be determined by a vote of the town at a legal meeting held for that purpose. Such bonds, notes or scrip shall bear on their face the words, Town of Winthrop Water Loan, shall be payable at the expiration of periods not exceeding thirty years from the date of issue, shall bear interest, payable semi-annually, at a rate not exceeding five per cent. per annum, and shall be signed by the treasurer of the town and countersigned by the water commissioners hereinafter provided for. Said town may sell such securities at public or private sale, or pledge the same for money borrowed for the purposes of this act, and upon such terms and conditions as it may deem proper: *provided*, that such securities shall not be sold for less than the par value thereof. Said town shall provide at the time of contracting said loan for the establishment of a sinking fund, and shall annually contribute to such fund a sum sufficient with the accumulations thereof to pay

Proviso.

Sinking fund.

the principal of said loan at maturity. Said sinking fund shall remain inviolate and pledged to the payment of said loan and shall be used for no other purpose.

May provide for annual payments on loan.

SECTION 7. Said town instead of establishing a sinking fund may at the time of authorizing said loan provide for the payment thereof in such annual proportionate payments as will extinguish the same within the time prescribed in this act; and when such vote has been passed the amount required thereby shall without further vote be assessed by the assessors of said town in each year thereafter until the debt incurred by said loan shall be extinguished, in the same manner as other taxes are assessed under the provisions of section thirty-four of chapter eleven of the Public Statutes.

Payment of expenses, etc.

SECTION 8. Said town shall raise annually by taxation a sum which with the income derived from water rates will be sufficient to pay the current annual expenses of operating its water works, including therein any annual payment to said metropolitan water board, and the interest as it accrues on the notes, bonds and scrip issued as aforesaid by said town, and such contributions to the sinking fund and payments on the principal as may be required under the provisions of this act.

Penalty for corruption of water, etc.

SECTION 9. Whoever uses any water taken under this act without the consent of said town, or wilfully or wantonly corrupts, pollutes or diverts any of the waters taken or held by said town pursuant to the provisions of this act, or destroys or injures any structure, work or other property owned, held or used by said town under the authority and for the purposes of this act, shall forfeit and pay to said town three times the amount of damages assessed therefor, to be recovered in an action of tort; and upon conviction of either of the above wilful or wanton acts shall be punished by a fine not exceeding three hundred dollars or by imprisonment not exceeding one year.

Liability for payment of rent for use of water, etc.

SECTION 10. The occupant of any tenement shall be liable for the payment of the rent for the use of the water in such tenement, and the owner shall also be liable in case of non-payment by the occupant for all sums due for the use of water under this act, to be collected in an action of contract in the name of the town of Winthrop.

Water commissioners, election, terms, etc.

SECTION 11. Said town shall after the acceptance of this act, at a legal meeting called for the purpose elect by ballot three persons to hold office, one until the expiration of three years, one until the expiration of two years and one until the expiration of one year from the next succeeding annual town meeting, to constitute a board of water commissioners; and at each annual town meeting thereafter one such commissioner shall be elected by ballot for the term of three years. All the authority granted to the town by this act and not otherwise specially provided for shall be vested in said board of water commissioners, who shall be subject however to such instructions, rules and regulations as said town may impose by its vote. The said commissioners shall be trustees of the sinking fund herein provided for and a majority of said commissioners shall constitute a quorum for the transaction of business relative both to the water works and to the sinking fund. Any vacancy occurring in said board from any cause may be filled for the unexpired term by said town at any legal meeting held for the purpose.

To be trustees of sinking fund, etc.

Vacancy.

SECTION 12. Said commissioners shall fix such prices or rents for the use of water as shall produce annually as near as may be a net surplus over operating expenses, including therein any annual payment to said metropolitan water board, and interest charges equal to two per cent. of the total amount of the bonds, notes or scrip issued under this act, after paying all current expenses of operating the water works and interest upon loans, and after payment of all expenses for new construction, not exceeding one thousand dollars in any one year after the original construction. The net surplus aforesaid shall be paid into the sinking fund if any is established hereunder, and if said surplus does not equal two per cent. of the total amount of the bonds, notes and scrip issued under this act the town shall raise by general taxation a sum which with the surplus will equal said two per cent., and shall contribute said sum to the sinking fund. Said commissioners shall annually, and as often as the town may require, render an account of all their doings in relation to the sinking fund, and shall be governed by the provisions of section eleven of chapter twenty-nine of the Public Statutes, except as herein otherwise provided.

To fix prices for use of water, etc.

To render an account of their doings, etc.

SECTION 13. The town of Winthrop shall not proceed to supply itself and its inhabitants with water under the authority of this act until it shall have first purchased the property of the Revere Water Company, situated within the limits of said town of Winthrop, and all the rights and privileges annexed thereto

Town may purchase property of Revere Water Company, etc.

and necessary to the effectual enjoyment and use thereof, and also any rights and privileges that it may have acquired under chapter one hundred and forty-two of the acts of the year eighteen hundred and eighty-two and chapter two hundred and fifty-nine of the acts of the year eighteen hundred and eighty-four, or under any other act relating to the said company and the town of Winthrop, and said company is authorized to make the sale of said property, rights and privileges to said town, and said town is authorized to purchase the same and manage and use the property thus conveyed for the purposes and under the provisions of this act. Whenever within three years from the passage of this act said town shall by a majority vote of the legal voters of said town present and voting thereon at a legal meeting called for that purpose, or at any annual town meeting, vote to purchase said property, rights and privileges, the same shall thereupon become the property of said town, and said town shall pay to said company the fair value thereof, to be ascertained as hereinafter provided. In case said town and said company after a conference thereon shall be unable to agree upon the value of said property, rights and privileges, the supreme judicial court shall, upon application of either party and notice to the other, appoint three commissioners, of whom one shall be learned in the law and another shall be a skilled engineer, who shall determine the fair value of the property, rights and privileges, and whose award when accepted by the court shall be final; but said company shall not be entitled to receive any payment as hereinbefore provided, so long as any lien or any other incumbrance remains upon said property or any part thereof, unless said commissioners shall otherwise determine.

Commissioners to be appointed to determine value of property in case of failure to agree, etc.

To be submitted to voters at a legal town meeting, etc.

SECTION 14. This act, except as provided in section fifteen, shall take effect upon its acceptance by a majority vote of the voters of the town of Winthrop present and voting thereon at a legal meeting called for the purpose within three years from its passage; but the number of meetings so called shall not exceed three in any one year.

When to take effect.

SECTION 15. So much of this act as authorizes the submission of the question of its acceptance to the legal voters of said town shall take effect upon its passage, but it shall not take further effect unless and until accepted as hereinbefore provided by the qualified voters of said town. [*Approved April 6, 1898.*

[Chapter 392 of the Acts of the Year 1898.]

AN ACT RELATIVE TO SUPPLYING CERTAIN CITIES AND TOWNS WITH WATER FROM THE METROPOLITAN WATER WORKS.

Be it enacted, etc., as follows:

1895, 488, § 3, amended.

To construct, etc., a system of metropolitan water works.

Metropolitan Water District.

Certain cities and towns may be admitted, etc.

Proviso.

Section three of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five is hereby amended by inserting after the word "determine", in the twenty-eighth line, the words: — *provided*, that any such city or town shall first have acquired the works of any water company therein situated, constructed for the purpose of supplying said city or town or its inhabitants with water, — so as to read as follows: — *Section 3.* Said board, acting for the Commonwealth, shall construct, maintain and operate a system of metropolitan water works substantially in accordance with the plans and recommendations of the state board of health, contained in their report to the legislature of the year eighteen hundred and ninety-five, and shall provide thereby a sufficient supply of pure water for the following named cities and towns, and the inhabitants thereof, to wit: — The cities of Boston, Chelsea, Everett, Malden, Medford, Newton and Somerville, and the towns of Belmont, Hyde Park, Melrose, Revere, Watertown and Winthrop, which cities and towns shall constitute the Metropolitan Water District; shall secure and protect the purity of said water; shall on application furnish water to any city or town aforesaid that at the time of application owns its water pipe system; shall on application admit any other city or town, any part of which is within ten miles of the state house, into said water district, and furnish water to the same on the terms prescribed by this act for the cities and towns aforesaid, and on such payment of money as said board may determine; shall on application furnish water to any water company owning the water pipe system in any town within said ten miles, on such water company assuming the assessments of the town, if any, and making such payment of money as said board may determine; and may from time to time furnish water to any other city, town or water company, on such payment of money as said board may determine: *provided*, that any such city or town shall first have acquired the works of any water company therein situated, constructed for the purpose of supplying said city or town or its inhabitants

Distribution of payments of money, furnishing of water, etc.

with water. All payments of money aforesaid shall be distributed to the cities and towns in said district in proportion to the total amount of the annual assessments theretofore paid by them respectively. Said board shall furnish said water to the city, town or company, by delivering the same into a main water pipe, reservoir or tank of the city, town or company, under sufficient pressure for use without local pumping, unless delivered in some other manner by mutual agreement between the parties interested; and shall have the direction and control of the connections between the metropolitan and local systems. Said board may utilize the fall of water at any dam under their charge, and may thereby produce power or electricity, and may transmit such power or electricity by pipes, wires, or other suitable means, and sell the same, or the right to use such water, by written or other contract, to run for a term not exceeding fifteen years. Any person or corporation authorized by said board shall have all the powers relating to the production, sale and transmission of power and electricity given by this act to said board. [*Approved April 29, 1898.*

[Chapter 427 of the Acts of the Year 1898.]

AN ACT RELATIVE TO THE METROPOLITAN WATER SUPPLY.

Be it enacted, etc., as follows:

Disposition of annual income from water works of city of Boston.

SECTION 1. The income received each year by the city of Boston from its water works shall be applied prior to the first day of February of the following year, to meet the expenses incurred for maintenance of its water works, including the operation, extension, improvement and renewal of said works, to meet the interest and sinking fund requirements of the loans issued for said works, and to meet the assessment apportioned to said city under chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five; and the balance of said income remaining at said date and not otherwise provided for shall be paid into the sinking funds for said loans until such time as in the opinion of the commissioners of sinking funds of said city such funds with their probable accumulations are sufficient to meet said loans at maturity without further contributions from any other source, and thereafter shall be added to the capital of the fund provided for in the following section.

Certain sums to be paid to commissioners of sinking funds, etc.

SECTION 2. All sums received since February first, eighteen hundred and ninety-eight, or that may hereafter be received by said city for the taking of any part of its water works under the provisions of said chapter, shall be paid to said commissioners of sinking funds; and such sums, together with any payments that may be made of the income from the city's water works, as provided in section one of this act, shall, until otherwise authorized by the legislature, be invested, so far as practicable, in securities issued from time to time by said city, and the balance in other securities, and be held and managed by said sinking funds commissioners as a separate fund, and the interest received from said fund shall so far as required be paid to the treasurer of said city and used to meet the balance, if any, required for the purposes to which the income from the water works of said city may be applied under section one of this act; and if in any year the total income from said fund shall exceed the amount required to be so used the excess shall be added to the capital of said fund.

City not to issue notes, bonds, etc., without authority.

SECTION 3. Said city shall not issue any notes, bonds or scrip for water purposes without further authority from the legislature.

When to take effect.

SECTION 4. This act shall take effect upon its acceptance by the city council of the city of Boston. [*Approved May 13, 1898.*

[Chapter 464 of the Acts of the Year 1898.]

AN ACT TO AUTHORIZE THE METROPOLITAN WATER BOARD TO CONVEY AND EXCHANGE LAND AND EASEMENTS.

Be it enacted, etc., as follows:

Metropolitan water board may convey and exchange land and easements, etc.

SECTION 1. In any case in which the metropolitan water board is now authorized by law to sell real estate, instead of making such sale said board may convey real estate and receive therefor in exchange other real estate, the title of the same to be taken in the name of the Commonwealth, and may cause money to be paid or received to make the exchange equal. And said board may from time to time make grants or conveyances of easements and receive therefor in exchange other easements, money or such other considerations as may be deemed suitable by said board, the title of such easements to be taken in the name of the Commonwealth. All money received shall be paid into the treasury of the Commonwealth and be applied in the manner designated in section eighteen of when such vote has been passed the amount required thereby shall without further vote be assessed by the assessors of said town in each year thereafter until the debt incurred by said loan shall be extinguished, in the same manner as other taxes are assessed under the provisions of section thirty-four of chapter eleven of the Public Statutes.

Payment of expenses, etc.

SECTION 8. Said town shall raise annually by taxation a sum which with the income derived from water rates will be sufficient to pay the current annual expenses of operating its water works, including therein any annual payment to said metropolitan water board or to the city of Lynn, and the interest as it accrues on the notes and bonds issued as aforesaid by said town, and such contributions to the sinking fund and payments on the principal as may be required under the provisions of this act.

Penalty for corruption of water, etc.

SECTION 9. Whoever uses any water taken under this act without the consent of said town, or wilfully or wantonly corrupts, pollutes or diverts any of the waters taken or held by said town pursuant to the provisions of this act, or destroys or injures any structure, work or other property owned, held or used by said town under the authority and for the purposes of this act, shall forfeit and pay to said town three times the amount of damages assessed therefor, to be recovered in an action of tort; and upon conviction of either of the above wilful or wanton acts shall be punished by a fine not exceeding three hundred dollars or by imprisonment not exceeding one year.

Liability for payment of rent for use of water, etc.

SECTION 10. The occupant of any tenement shall be liable for the payment of the rent for the use of water in such tenement, and the owner shall also be liable in case of non-payment by the occupant for all sums due for the use of water under this act, to be collected in an action of contract in the name of the town of Swampscott.

Water commissioners, election, terms, etc.

SECTION 11. Said town shall at a legal meeting called for the purpose elect by ballot three persons to hold office, one until the expiration of three years, one until the expiration of two years and one until the expiration of one year from the next succeeding annual town meeting, to constitute a board of water commissioners; and at each annual town meeting thereafter one such commissioner shall be elected by ballot for the term of three years. No person shall be a water commissioner who holds any other town office by popular election. All the authority granted to the town by this act and not otherwise specially provided for shall be vested in said board of water commissioners, who shall be subject however to such instructions, rules and regulations as said town may impose by its vote. The said commissioners shall be trustees of the sinking fund herein provided for and a majority of said commissioners shall constitute a quorum for the transaction of business relative both to the water works and to the sinking fund. Any vacancy occurring in said board from any cause may be filled for the unexpired term by said town at any legal meeting held for the purpose.

To be trustees of sinking fund, etc.

Vacancy.

SECTION 12. Said commissioners shall fix such prices or rents for the use of water as shall produce annually as near as may be a net surplus over operating expenses, including therein any annual payment to said metropolitan water board or to the city of Lynn, and interest charges equal to two per cent. of the total amount of the bonds or notes issued under this act, after paying all current expenses of operating the water works and interest upon loans. The net surplus aforesaid shall be paid into the sinking fund, if any is established hereunder, and if said surplus does not equal two per cent. of the total amount of the bonds and notes issued under this act the town shall raise by general taxation a sum which with the surplus will equal said two per cent., and shall contribute said sum to the sinking fund. Said commissioners shall annually, and as often as the town may require, render an account of all their doings in relation to the sinking fund, and shall be governed by the provisions of section eleven of chapter twenty-nine of the Public Statutes, except as herein otherwise provided.

To fix prices for use of water, etc.

To render an account of their doings, etc.

SECTION 13. This act shall take effect upon its passage. [*Approved April 6, 1898.*

[Chapter 295 of the Acts of the Year 1898.]

AN ACT TO PROVIDE FOR A WATER SUPPLY FOR THE TOWN OF WINTHROP.

Be it enacted, etc., as follows:

SECTION 1. The town of Winthrop may supply itself and its inhabitants with water for the extinguishment of fires and for domestic and other purposes, obtaining the same from the metropolitan water board, as provided in chapter four hundred

Town of Winthrop may supply itself with water, etc.

and eighty-eight of the acts of the year eighteen hundred and ninety-five, may establish fountains and hydrants and relocate or discontinue the same, and may regulate the use of such water and fix and collect rates to be paid for the use of the same.

May hold and convey certain water, take certain lands, etc.

SECTION 2. Said town for the purposes aforesaid may hold and convey through said town the water to be furnished by said metropolitan water board as hereinbefore provided, and may also take and hold, by purchase or otherwise, all lands, rights of way and easements necessary for holding, storing, purifying and preserving such water and for conveying the same to any part of said town of Winthrop; may erect on the lands thus taken or held proper dams, reservoirs, buildings, fixtures or other structures; may make excavations, procure and operate machinery, and provide such other means and appliances as may be necessary for the establishment and maintenance of complete and effective water works; may construct and lay down conduits, pipes and other works, under and over any lands, water courses, railroads or public or private ways, and along any such ways in such manner as not unnecessarily to obstruct the same; and for the purpose of constructing, maintaining and repairing such conduits, pipes or other works, and for all proper purposes of this act, said town may dig up any such lands, and may enter upon and dig up any such ways in such manner as to cause the least hindrance to public travel thereon. The title to all lands taken or purchased under the provisions of this act shall vest in said town, and the land so taken may be managed, improved and controlled by the board of water commissioners hereinafter provided for, in such manner as they shall deem for the best interests of said town.

May erect structures, lay pipes, etc.

Title to lands to vest in town, etc.

Description of lands, etc., to be recorded.

SECTION 3. Said town shall, within ninety days after the taking of any lands, rights of way or easements as aforesaid, otherwise than by purchase, file and cause to be recorded in the registry of deeds for the county of Suffolk a description thereof sufficiently accurate for identification, with a statement of the purpose for which the same were taken, signed by the water commissioners hereinafter provided for.

Damages.

SECTION 4. Said town shall pay all damages sustained by any person or corporation in property by the taking of any lands, rights of way or easement, or by any other thing done by said town under the authority of this act. Any person or corporation sustaining damages as aforesaid under this act, who and eighty-eight of the acts of the year eighteen hundred and ninety-five: *provided, however*, that said town shall not, until two years after the transfer of the works, as aforesaid, lose, by operation of the statute of limitations, any right of recovery under the provisions of said act for damages sustained by any interference with its sewerage system or with its drainage rights or privileges; and if it so elect shall have the right to set off such damages against any claim for damages made for the transfer of said works, as aforesaid.

Proviso.

Sewers, drains, etc., may be laid under and along any street, etc.

SECTION 5. The metropolitan water board may, for the purposes of this act, carry the sewers, drains, pipes and conduits laid or constructed, as aforesaid, under and along any street, railroad or highway in such manner as not unnecessarily to obstruct the same, and may do any other act or thing proper for said purposes.

Works to be deemed a part of the metropolitan water works.

SECTION 6. The works constructed hereunder shall, while they remain under the control of the metropolitan water board, be deemed a part of the metropolitan water works, and all of the provisions of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five relating to the incurring of expense for construction, maintenance and operation, to the payment of the costs thereof, to the sale and leasing of property, and to the disposal of the proceeds from the sales of property and from other operations of said board, and all other provisions of said act so far as they are applicable and not inconsistent herewith shall apply to the works constructed hereunder.

Towns of Clinton and Lancaster to be exempt from damages.

SECTION 7. The metropolitan water board shall save harmless the towns of Lancaster and Clinton from all damages for injuries resulting from any defect or want of repair in any road, street or highway, caused by digging up the same or by constructing, laying, maintaining or repairing any works to be constructed hereunder.

Plans to be approved by the state board of health.

SECTION 8. No sewers or other works shall be constructed and maintained under the authority of this act until the plans have been approved by the state board of health.

SECTION 9. This act shall take effect upon its passage.
[*Approved June 22, 1898.*

the principal of said loan at maturity. Said sinking fund shall remain inviolate and pledged to the payment of said loan and shall be used for no other purpose.

May provide for annual payments on loan.

SECTION 7. Said town instead of establishing a sinking fund may at the time of authorizing said loan provide for the payment thereof in such annual proportionate payments as will extinguish the same within the time prescribed in this act; and when such vote has been passed the amount required thereby shall without further vote be assessed by the assessors of said town in each year thereafter until the debt incurred by said loan shall be extinguished, in the same manner as other taxes are assessed under the provisions of section thirty-four of chapter eleven of the Public Statutes.

Payment of expenses, etc.

SECTION 8. Said town shall raise annually by taxation a sum which with the income derived from water rates will be sufficient to pay the current annual expenses of operating its water works, including therein any annual payment to said metropolitan water board, and the interest as it accrues on the notes, bonds and scrip issued as aforesaid by said town, and such contributions to the sinking fund and payments on the principal as may be required under the provisions of this act.

Penalty for corruption of water, etc.

SECTION 9. Whoever uses any water taken under this act without the consent of said town, or wilfully or wantonly corrupts, pollutes or diverts any of the waters taken or held by said town pursuant to the provisions of this act, or destroys or injures any structure, work or other property owned, held or used by said town under the authority and for the purposes of this act, shall forfeit and pay to said town three times the amount of damages assessed therefor, to be recovered in an action of tort; and upon conviction of either of the above wilful or wanton acts shall be punished by a fine not exceeding three hundred dollars or by imprisonment not exceeding one year.

Liability for payment of rent for use of water, etc.

SECTION 10. The occupant of any tenement shall be liable for the payment of the rent for the use of the water in such tenement, and the owner shall also be liable in case of non-payment by the occupant for all sums due for the use of water under this act, to be collected in an action of contract in the name of the town of Winthrop.

Water commissioners, election, terms, etc.

SECTION 11. Said town shall after the acceptance of this act, at a legal meeting called for the purpose elect by ballot three persons to hold office, one until the expiration of three

To be trustees of sinking fund, etc.

Vacancy.

years, one until the expiration of two years and one until the expiration of one year from the next succeeding annual town meeting, to constitute a board of water commissioners; and at each annual town meeting thereafter one such commissioner shall be elected by ballot for the term of three years. All the authority granted to the town by this act and not otherwise specially provided for shall be vested in said board of water commissioners, who shall be subject however to such instructions, rules and regulations as said town may impose by its vote. The said commissioners shall be trustees of the sinking fund herein provided for and a majority of said commissioners shall constitute a quorum for the transaction of business relative both to the water works and to the sinking fund. Any vacancy occurring in said board from any cause may be filled for the unexpired term by said town at any legal meeting held for the purpose.

To fix prices for use of water, etc.

To render an account of their doings, etc.

SECTION 12. Said commissioners shall fix such prices or rents for the use of water as shall produce annually as near as may be a net surplus over operating expenses, including therein any annual payment to said metropolitan water board, and interest charges equal to two per cent. of the total amount of the bonds, notes or scrip issued under this act, after paying all current expenses of operating the water works and interest upon loans, and after payment of all expenses for new construction, not exceeding one thousand dollars in any one year after the original construction. The net surplus aforesaid shall be paid into the sinking fund if any is established hereunder, and if said surplus does not equal two per cent. of the total amount of the bonds, notes and scrip issued under this act the town shall raise by general taxation a sum which with the surplus will equal said two per cent., and shall contribute said sum to the sinking fund. Said commissioners shall annually, and as often as the town may require, render an account of all their doings in relation to the sinking fund, and shall be governed by the provisions of section eleven of chapter twenty-nine of the Public Statutes, except as herein otherwise provided.

Town may purchase property of Revere Water Company, etc.

SECTION 13. The town of Winthrop shall not proceed to supply itself and its inhabitants with water under the authority of this act until it shall have first purchased the property of the Revere Water Company, situated within the limits of said town of Winthrop, and all the rights and privileges annexed thereto

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